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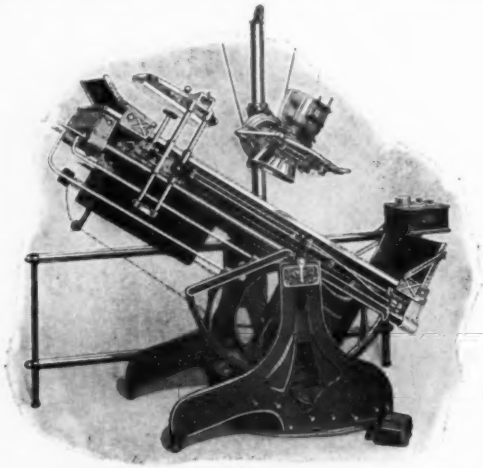

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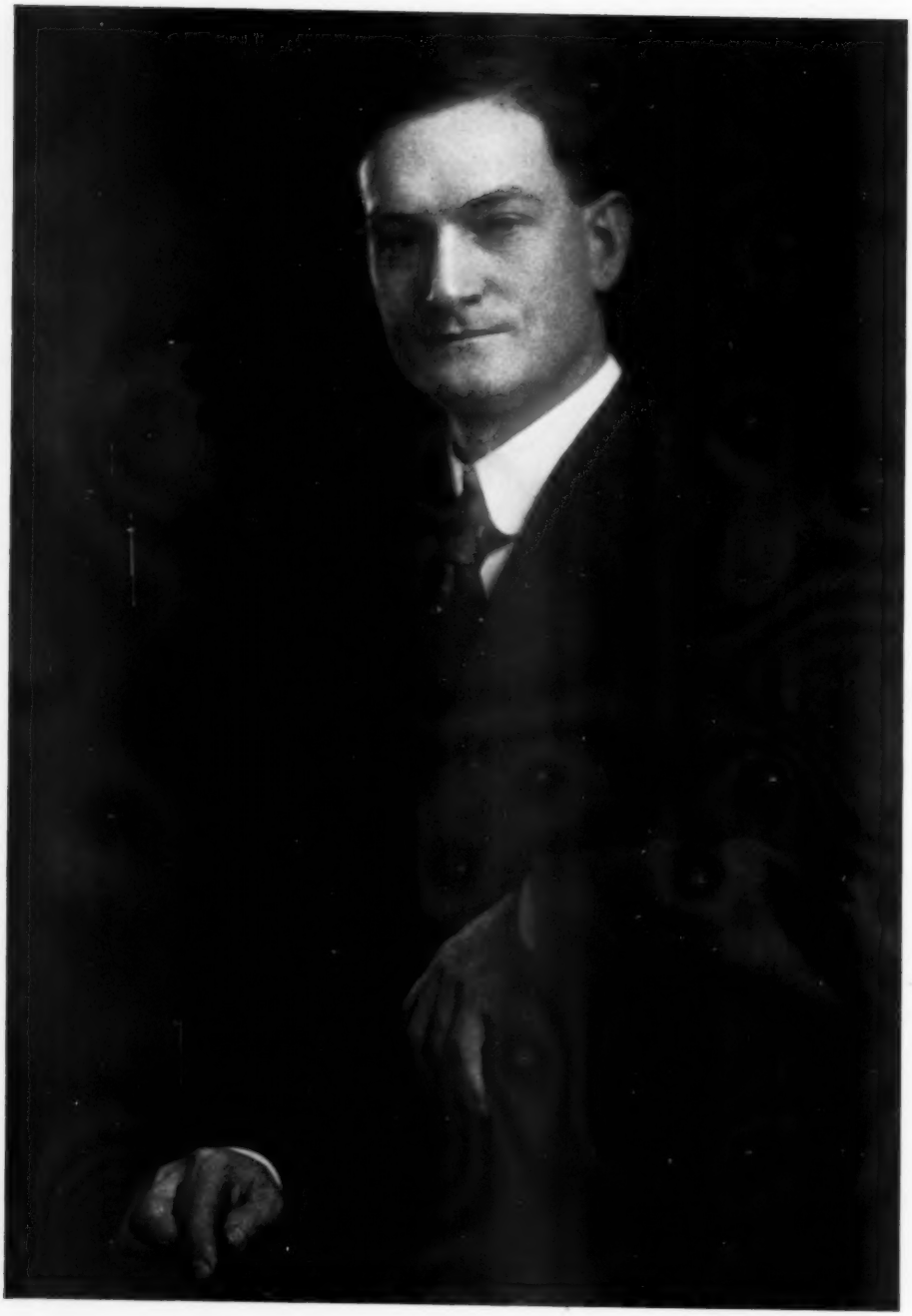

Arthur C Christie

THE AMERICAN JOURNAL OF ROENTGENOLOGY

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X-RAY EXAMINATION OF THE CHEST AND AN X-RAY CLASSIFICATION OF PULMONARY TUBERCULOSIS*

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THE object of this paper is to bring to the profession a practical method of *x*-ray examination of the chest, based upon 10,000 such examinations, each checked by careful physical examination and history or autopsy, and to present the *x*-ray classification of tuberculosis used at the Cincinnati Tuberculosis Sanitorium.

The primary purpose of the examination is to locate and describe abnormal densities and thus detect tuberculosis, identify its type, and differentiate it from other chest lesions. In this way I am able to classify tuberculosis, arrive at a more perfect diagnosis, and secure a workable basis for prognosis, and am enabled with certainty to outline the necessary treatment from the very beginning of my care of the case. This is made possible because stereoscopic chest plates are of prime importance in determining pulmonary pathology.

The limits of an *x*-ray chest examination must be frankly stated. *X*-ray studies of lungs and chests by many workers during the last twenty years have proven that a physical examination, even in expert hands, has great limitations. The limitations of each method have been proclaimed by men who were not fully familiar with the method they criticised, so that to-day the profession has only a hazy knowledge of what it may expect from each method.

The greatest value of any single sign of a physical examination of the chest is the detection, location, and classification of râles. This is so important that our late army experience has developed the erroneous theory that clinical tuberculosis should only be diagnosed by râles. The truth of the matter is that you may have râles upon inspiration, over a limited area, without tuberculosis, and that you may have active tuberculosis without râles.

In a case of incipient tuberculosis the râle is of great importance for the same reason that the *x*-ray fan is important, viz., that the common adult pulmonary lesion is cone shaped and its base comes to the pleura. Thus, when you have the adult type of tuberculosis you have inflammation with exudate at the point of inoculation, which partially fills the air cells and distal portion of the bronchial tree; the extent of the lesion is limited by the septa of the lung, which extends into the lung from the pleura in such a manner as to form a cone with its base at the pleura. The stethoscope easily detects such lesions because of their superficial location,

*Read at the Twenty-first Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY, Minneapolis, Minn., Sept. 14-17, 1920.

and we hear a shower of fine râles breaking immediately under the ear. They are usually heard at the beginning of inspiration, and because they are generally not so acute as other forms of pneumonia the patient must often exhale and cough before they are brought out. It must be realized that this is not a pathognomonic sign of active pulmonary tuberculosis but is a sign of localized inflammatory exudate from which tuberculosis must be excluded. Early tuberculous adult lesions are most commonly found in the apex of a lobe—sometimes in the apex of a lower lobe. So the location of such findings must be carefully considered when making a diagnosis.

It is not generally realized that râles due to tuberculous lesions frequently disappear after a few weeks or months and that râles due to localized apical pneumonia, such as we had during the late epidemic, frequently persist for months. Further, it is not generally known that we have at times central spherical areas of tuberculosis which may give no such râles. Most important to remember is that we may have very extensive lesions of tuberculous caseous bronchopneumonia without physical signs. The purpose of these few remarks upon physical signs is not to discuss the physical signs of tuberculosis, but to show some of the values and limitations of the *x*-ray.

While râles due to pulmonary tuberculosis may come and go, this is not true of the abnormal densities in the lungs due to tuberculous lesions. They may change but they never go. Thus we have a record of the past, and although the râles have disappeared an old area of tuberculosis is easily detected by the *x*-ray. A fan due to a recent tuberculous invasion, in which the râles may be very characteristic and due to recent localized tuberculous exudate, is difficult to detect upon the *x*-ray plate. Thus, the usual error in reading *x*-ray plates of tuberculous cases is to overlook recent active lesions, or to diagnose non-tuberculous lesions of similar density as tuberculosis. The usual error of the clinician is to overlook old lesions and thus underestimate the extent of the pathology. Such densities must be differentiated from artefact, and from localized exudate due to other causes. Artefacts are corrected by proper roentgen technique.

I wish to call attention to the limits of a roentgen examination of the chest due to error of technique. Breathing during exposures or between stereoscopic exposures may obscure delicate pneumonic fans or may cause them to appear when they do not exist. If plates are repeatedly taken in the same position, it is easy to determine the normal position of the trunks and thus localize the lobes of the lungs. Many positions can be used, but for each position the normal anatomy must be worked out. I have carefully worked out the anatomy for one position, and if the lobes of the lung are to be determined by my method, that position must be maintained. I have witnessed some grave mistakes made in localizing a lesion, by failing to observe the positions of plate, tube and patient described in one method, yet trying to read these plates by that method. I have seen the same lack of correlation by having Dunham's fans pointed out to me in pictures of perfectly healthy men who have breathed between stereoscopic exposures in three-second exposures.

Hard tubes with rapid exposures do not obscure the delicate fans, but a tube with a five inch spark-gap or less exposed for three or four seconds will cut out very delicate fans.

Errors of interpretation are the most difficult to overcome. Nothing can overcome this, but a knowledge of the normal lung anatomy and the normal lung densities will greatly reduce the errors. (Miller[1] and Dunham.[2])

At this point I wish to state that a delicate fan limited to one apex of an adult should be noted and described, but should not be diagnosed as pulmonary tuberculosis, because it is probably due to other etiological factors. Let us look at the reason. The lesion, if in the lung, is due to exudate. It might be a pleural lesion mistaken for a fan. If due to tuberculosis it is our first exudative lesion, and it is very unusual to find a first exudate. Such patients are not sick and seldom consult a physician, while patients with localized pneumonia due to acute infections are usually

sick or have troublesome symptoms. Thus you can differentiate between tuberculous and apical râles which persist after la grippe and influenza. If possible, it is important to determine whether such densities are actually within the lung or in the pleura. If such a lesion is active it can easily be determined by the stethoscope. Therefore, the clinician's attention should be called to the density and its character described. Such lesions when due to tuberculosis are easily arrested and the patient should not be branded as tuberculous. Such densities often exist for life after an attack of pneumonia or empyema, or a healed tuberculous lesion, and it is often impossible to decide the clinical significance of such densities from the plates alone. Age should always be considered—they are of less significance after thirty. Thus we have definite limitations of the *x*-ray which should be acknowledged and left to the decision of the clinician.

When both apices are involved we have a better chance, because if one is due to tuberculosis the pulmonary lesions are of different ages and one density will differ from the other. Thus it is usually easy to say definitely whether one or more of these lesions are within the lung tissue. But still we are dealing with slight lesions and must be guarded. The clinician should give greater weight to such findings, but we must be guarded in our reports and frankly acknowledge another limitation. Activity in such a case is very difficult to determine from the plates.

The most excusable error is when we find one or more old tuberculous fans and a recent active fan below this. Such a lesion should always be diagnosed as recently active tuberculosis; yet I have had two such cases which were due to influenza engrafted upon an old tuberculous lesion. Such an error is on the safe side, because unless this patient is treated as tuberculous there is every likelihood that the old lesion will be reactivated by the acute process. This is another limitation.

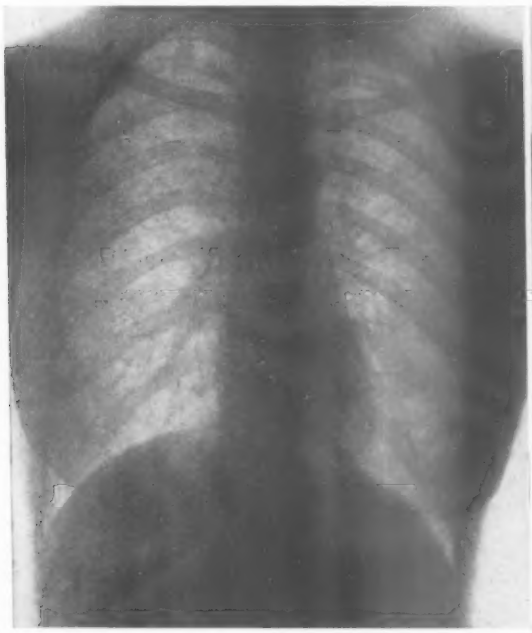

FIG. 1. No. 1986.—Plates taken by Coolidge tube medium focus with more than 9 inch spark, 50 ma., 39 inches distance, a half second exposure on a seed plate without screen, of a light-framed woman weighing 119 pounds. Plate is normal except for some ptosis. The value of this technique is that it holds the lung markings equally well at apex and base.

FIG. 2. No. 1865.—Child, age eight. Case showing few calcified nodes at the hilum which probably indicate tuberculous infection. There is no lesion in the lung. This child has a tuberculous history, but has no physical signs or symptoms. Heart enlarged to R. which is unusual.

Pneumonoconiosis, acute bronchopneumonia and malignancy will be considered later.

In an article entitled "*X*-Ray Chest Manual" I covered the technique and reading of *x*-ray plates. Since this was written I have developed a Coolidge tube technique which I wish to report, and I wish further to add a statement as to the value of the fluoroscope. The fluoroscope can in no way compare with the stereoscopic chest plates in detecting slight lesions, such as minimal tuberculous lesions, nor in studying the various pathology of gross tuberculous lesions. Its value lies in studying motion. Thus the movement of the diaphragm, the pulsation of the heart and the aorta, posterior mediastinal space, and the passing of the barium bolus through the esophagus can be best studied by the fluoroscope.

A medium focused universal Coolidge tube, 39 inches from the plate, excited by 40 ma. to 60 ma. (with a 9 inch back up between points, under full load), exposed for a half second, will take a good chest picture of a 150 pound man upon seed plates. It is necessary to develop these longer than the usual exposure, sometimes as much as fifteen minutes. To do this it is necessary that the chemicals be clean and the temperature 65° to 68°. (Fig. 1.)

If plates are taken at 39 inches they can be used with proper modifications to determine the size of the heart. Such technique will bring out the lung markings so clearly that the bronchus of the lung tree can be studied readily from good stereoscopic plates.

Before reading and interpreting lung plates it is necessary to understand the normal plate, or rather, the average plate of normal individuals at various ages. Almost every scar and calcified area within the lung leaves a mark upon the plate, and as all adults have such areas they must be recognized for their true value. Thus the marks of tuberculosis are almost universally observed in adults who have grown up in congested communities. They have been infected with tuberculosis but they do not suffer from tuberculosis. "They have the infection but not the disease." It is obvious that a diagnostic procedure which detects and does not differentiate such infection and disease has little value. Lesions due to infections which have healed are probably our best protection against pulmonary tuberculosis. Calcification at the roots of the lung of an adult chest, in which no fans can be demonstrated at the periphery, should be considered as resistance and not disease. This truth was suggested early in my investigations, when the first fifty sets of stereoscopic chest plates of healthy adults showed much greater calcification within the hilum and much more thickening and studding of the trunks than did fifty cases suffering with active pulmonary tuberculosis with which they were compared.

Therefore, it was evident from the very first that the roentgen examination to be of value must differentiate between infections which had healed and which were a protection and those which were active, had clinical significance or limited lung function, and were a danger to the patient. Here I wish to make the general statement that when we have definite fans of increased density within the lung, we are dealing with a lesion which causes loss of lung function, whether we have an active process due to tuberculosis or pneumonia of other etiological factors, or an inactive lesion such as pneumonoconiosis.

It is the characteristic densities of a fan that are pathognomonic of tuberculosis and not the fan itself. The fan is characteristic of a pulmonary lesion and results from the anatomy of and physiology within the lung, but the characteristic tuberculous density results from the pathology of tuberculosis and the tubercle is far from being the only pathology. The tubercle alone, even the conglomerate tubercle or individual areas of caseous bronchopneumonia as seen upon the plate, are not characteristic of tuberculosis.

If we exclude acute pneumonic infections of the lung, pulmonary tuberculosis is the most common lesion we find. Its clinical and pathological manifestations are so varied that tuberculosis must be eliminated before any other diagnosis can be substantiated.

Therefore, if in reading chest plates we start with a knowledge of the chest plates in healthy individuals and a knowledge of the

chest plates of the various forms of tuberculosis, we have gone far in mastering this difficult subject. No roentgenologist would expect to read bone plates without a careful study of the anatomy of the part studied. This preliminary necessity is even more true in the interpretation of chest plates. The physiology of the lung, especially the lymph flow as well as the pathogenesis of tuberculosis, must be undestood. Where pulmonary tuberculous lesions start—how they spread and how the lesions in the child differ from those in the adult and how each is recorded upon the roentgen plate—will be dealt with under Classification. Here I wish to impress the fundamental truth that without these preliminary necessities it is hopeless to interpret chest plates and to deduce from them the all-important prognosis.

Pulmonary tuberculosis is not always present when tubercle bacilli are reported in the sputum. For fully ten years I have realized the truth of this statement, but have not had sufficient proofs to allow it to appear in print under my name. To-day I fearlessly state the truth. The proofs are beyond question, but I hasten to add that such cases are rare, and such a diagnosis can only be made after great care. I have had 8 cases in this series of our 10,000; 2 proved to be acid-fast bacilli other than tubercle bacilli, and 6 were due to old nodes rupturing into a bronchus, from which large numbers of bacilli were expelled for a few days and then were found no more. No evidence of lung involvement was ever found.

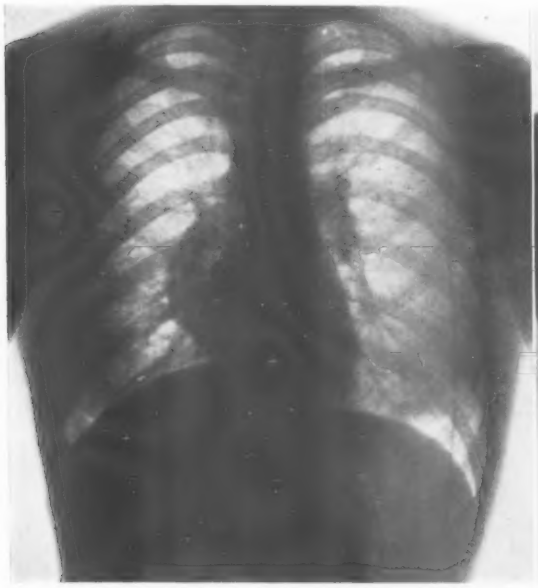

FIG. 3. No. 1770.—Child, age fourteen. Extensive calcification of nodes at the hilum with no parenchymal lesion.

FIG. 4. No. 1912.—Puerile type of tuberculosis in child. Massive tuberculous pneumonia with large caseous nodes at hilum. No apical lesion. Findings verified at autopsy. Child colored, age fifteen.

FIG. 5. No. 1736.—Puerile type of tuberculosis found in an adult. Massive tuberculous pneumonia, left side, without apical lesion. Negro, age nineteen.

I cannot say that these 8 cases are the only ones which have occurred, but they are the only ones which I have proven.

Many more cases of lung stones have occurred, some have been without tubercle bacilli in the sputum and some have had definite pulmonary lesions. These 6 had no pulmonary lesions by physical examination, by *x*-ray examination, or by subsequent histisms, and an important group are those nodal infections in which the pulmonary lesions have healed but which later rupture into a bronchus. If the small cavity quickly drains, the lesion is soon healed, to the great surprise and chagrin of the physician. It is possible to conceive that the patient may be reinfected by such a discharge or that a calcified stone, which for some reason of size or

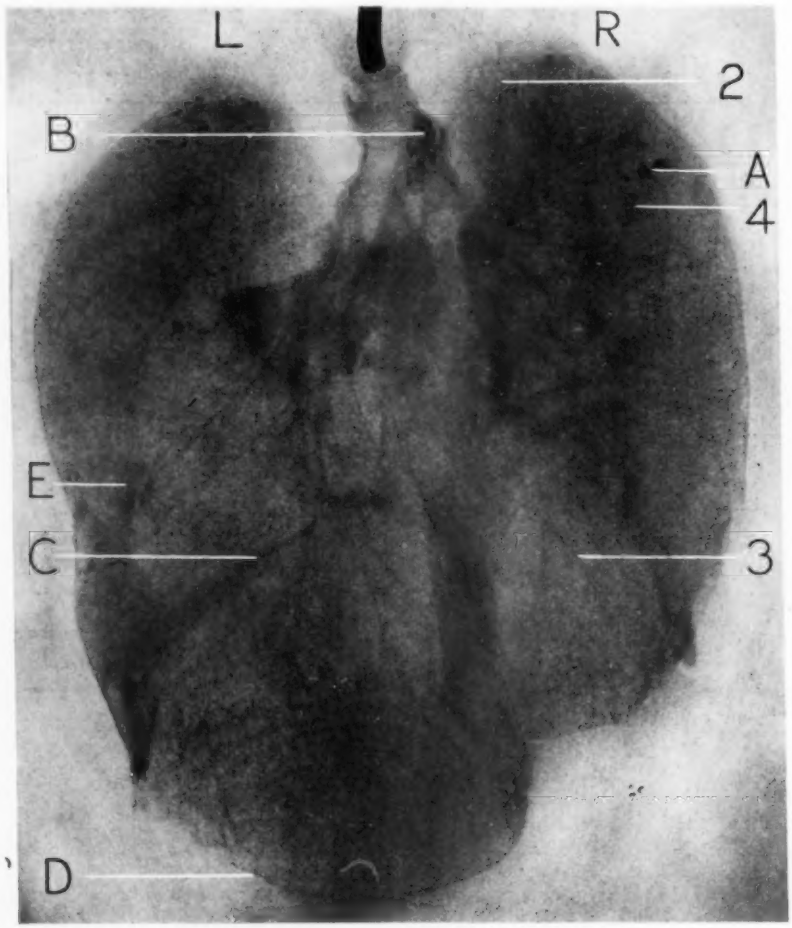

FIG. 6. No. 1256.—E. S. Active miliary tuberculosis. (Such a case has rarely come for autopsy.)

tory. It is stated over and over again that the presence of tubercle bacilli in the sputum is the one infallible sign of pulmonary tuberculosis, and it is this broad statement which I wish to challenge by stating that it is not infallible, but that it is the one which is most nearly infallible. Most errors arise by improper technique in preparing and interpreting slides, some from other acid-fast organposition has not been expelled, may keep up cough by irritation. In these 6 cases reinfection did not take place, and an irritating cough did not follow, and 5 of them did expectorate lung stones. I would not have had these histories of lung stones had I not impressed upon the patients the necessity of watching for them.

These cases were found by making routine

stereoscopic chest examinations and especially by studying all cases with a clinical diagnosis of tuberculosis which did not show positive evidence of pulmonary tuberculosis upon the plates.

In the same manner many cases of bronchiectasis are found as well as a few abnormal densities in the lungs which promptly clear up with antisyphilitic treatment.

Generally an *x*-ray diagnosis of pulmonary tuberculosis should be limited to parenchymal tuberculosis in the adult. It is unwise to read peribronchial tuberculosis and hilum tuberculosis from an *x*-ray plate. The reason for this is simple. As stated above, we can seldom determine whether such densities result from healed lesions (infection) or active lesions (disease). They may be roughly considered active in a child and healed in an adult. They can never be considered tuberculous without calcification. Heavy trunks and hilum shadows result from many pulmonary infections, and as all adults have suffered from pulmonary infections by the tubercle bacillus or some other organism it is manifest that all adults will show peribronchial thickening and heavy hilum densities. I know of no way to separate these groups by the *x*-ray plate, and I have lungs which have been *x*-rayed to determine this point (Fig. 11). It is true that heavy trunks in the upper lobes are often associated with tuberculosis, but it is also true that if stereoscopic plates are carefully taken and carefully read, small fans will be found involving the linear markings beyond these trunks.

Pathologically peribronchial and hilum tuberculosis exist, but we have no way of deciding when they have clinical significance or when the densities are caused by infection other than tuberculosis.

I have not found the use of such distinctions necessary to check plate readings with clinical and pathological studies and conclude that when unaccompanied with fans peribronchial thickening in the adult has little clinical significance, and should not be described in the report. Its greatest use, as I have seen it, has been to furnish a loophole for the roentgenologist. Thickened trunks and heavy hilum densities may be valuable in reading the plates of children, but only as a study, not as a final diagnosis.

Heavy trunks and heavy hilum shadows containing definite caseous or calcareous areas in children's plates, according to my present knowledge, may be considered tuberculous, but I am unwilling to go farther unless they show definite fans and can be classed as adult tuberculosis.

There is a peculiar calcified area seen in the hilum which has clinical significance. This I have termed a caseocalcareous node.

FIG. 7. No. 302.—Healed miliary tuberculosis.

Upon the plate it has the density of calcium. It is usually quite large and can be seen to be made up of many small flakes of calcium rather than one stone. Upon section we find a soft caseous center containing microscopic calcium and large, hard flakes of calcium around the periphery. Such lesions I have never found to be healed and they should always be considered as potential foci of infection.

AN X-RAY CLASSIFICATION OF PULMONARY TUBERCULOSIS

The lung with its pathology is regarded as a whole adaptable to classification, especially to *x*-ray work.

1. *Adult Tuberculosis:*
   Syn. Secondary tuberculosis,
   Nodose tuberculosis,

Apical tuberculosis,
Chronic fibroid tuberculosis,
Tuberculosis in the sensitized patient.

(*a*) Apical fibroid tuberculosis. (Fig. 8.)
Earliest findings in localized tuberculous pneumonia; if lesion extends, chronic fibroid tuberculosis develops. (Fig. 9.)

(*b*) Gelatinous and caseous bronchopneumonia with apical lesions. (Fig. 10.)

(*c*) Lobar caseous pneumonia with apical lesions. (Fig. 10.)

(*d*) Fibrous pleurisy—pleural exudate.

2. *Puerile or Primitive Tuberculosis:*
Syn. Childhood tuberculosis,
Tuberculosis in the non-sensitized patient,
Focal tuberculosis.

(*a*) Primary lesion and tuberculous nodes. (Figs. 2, 3.)

(*b*) Miliary tuberculosis. (Fig. 6.)

(*c*) Basal tuberculosis. (Fig. 5.)

(*d*) Tuberculous caseous broncho- and lobar pneumonia (without apical lesions). (Fig. 5.)

(*e*) Caseous pleurisy.

There have been so many classifications of tuberculosis that to-day there can be only two excuses for attempting a new one—either that the writer may frankly express the limitations of his knowledge, which means his ignorance, or that by such a sacrifice he may help someone struggling with the problem of the disease. I have hesitated many years before presenting this classification. It has been of help to me and my associates, and I finally formally present it to this Society. Its value lies in the description of the peculiar densities which are associated with each type seen upon the plate; the separation of the disease into the peurile and adult types, which has been so clearly presented by Opie,[3] also in emphasizing that these types are dependent upon the resistances of the economy, which differ greatly in the child and the adult. These are partially and indefinitely suggested by differences in the lymphatic system, hypersensitiveness and immunity.

At the very beginning of my work it was found that there were great differences between the plates of tuberculous children and tuberculous adults. It was a great satisfaction when in 1917 Opie proved that this difference was due to anatomical differences. This confirmed my unpublished work which showed that differences in the plates were due to differing lesions and not to imperfect *x*-ray technique.

It has been shown by Krause[4] that the tubercle bacillus grows very differently in sensitized and non-sensitized animals, and Col. Bushnell has brought a mass of evidence to prove that this holds good in man. He has also shown that non-sensitized adults of the aboriginal races suffer like children, and I have often seen children whose resistance was so great that they had definite fibroid fans containing well walled-off cavities.

It is, therefore, evident that age is only a partial factor, and that immunity or hypersensitiveness plays a part. The only method known of raising immunity is by inoculating an animal with the living tubercle bacillus. This has been done repeatedly by Webb, Krause and others in animals, and in congested communities all children receive it without expense—too often an overdose is administered. Thus before a child is ten he is usually sensitized, and has acquired a degree of immunity, and we may expect the characteristic adult fan lesions.

It is true that we have the adult lesions in children and that we have peurile lesions in the adult. Either of these transformation types argues a grave prognosis. Adult lesions in the child, unless very slight, argue a far advanced disease; and the puerile type in the adult argues little resistance unless it is healed.

The differentiating roentgen characteristic of such lesions is the tuberculous fan. These are found constantly in the adult type, and I wish here again to describe them because they have been so frequently misunderstood. Allow me to repeat. The fan is not necessarily a characteristic of tuberculosis. It is a characteristic of a limited lung lesion. It is dependent upon the septa of the lung which are arranged so as to divide the lung into numerous cones or triangular pyramids. These limit the extent of many lung lesions as effectively as the lobe limits lobar pneu-

monia. They form the secondary lobules of the lung. When a lesion with differentiating density develops within one or a number of secondary lobules it may be recognized upon the plate. Such lesions are found in lobular pneumonia, pneumonoconiosis, infarct and tuberculosis. The pathognomonic tuberculous lesion is found when we have two or more

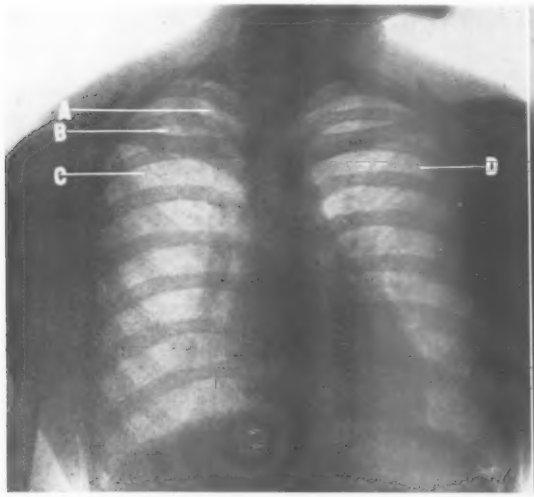

FIG. 8. No. 1075.—Adult type of tuberculosis showing definite "open" active apical fans involving vertebral first interspace trunk of upper right and second interspace trunk of upper left.
A. Right vertebral trunk.
B. Right first interspace trunk.
C. Right second interspace trunk.
D. Left second interspace trunk.

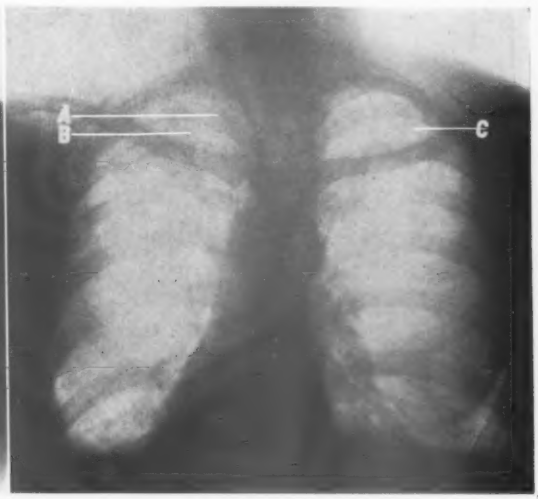

FIG. 9. No. 197.—Adult type of tuberculosis having definite fans of different densities.
A. Old lesion involving left first interspace trunk.
B. Recently active lesion involving left first interspace trunk.
C. Active lesion involving right first interspace trunk.

of these fans of differing density (Fig. 9). These densities may vary from a coarse interweaving to a faint cloud, to fine or coarse studding or to a complete blotting out of the lung structure. In advanced lesions the novice is unable to make out the fans, but they can usually be seen if the plates are carefully studied. Usually tuberculous fans form first in the upper part of the upper lobes.

I believe that I can amplify this truth if I digress and explain why tuberculous fans are of differing densities, how and why they differ from some other lesions and emphasize that primarily they are small and lie close to the periphery.

The early adult lesion is small because tuberculosis spreads very little by continuity but by the lymph-stream and later through the bronchus. The septa are prolongations of the pleura into the lung and they prevent the spread of the lesion beyond their boundaries because they carry the lymph flow away from the adjacent lobules, and barring cavitation the tubercle does not pass over this boundary. The lesion may invade the adjoining lobule, but it does not pass through the septa. In a sensitized animal such as a man there is great exudation at the point of infection which floods this small compartment of the lung, but this does not spread beyond the boundary unless it goes down one bronchus and up another and floods another lobule. Thus, the early fans are usually small and their size is dependent upon the amount of exudate. I do not know why these fans should be so near the pleura, but they are found both upon the plate and upon section. Certainly the lymphatics must play a great part in this. Possibly these infections near the center and roots of the lungs have better lymph drainage. The densities of these fans differ because they are of differing ages, and the various pathological lesions, such a fibrosis, caseation, calcification and exudation indicate stages of development. The former

will be presented by various degrees of clouds and studdings; the latter by a very delicate cloud. Thus localized, apical pneumonia as seen after influenza may simulate the latter, but could not the former.

Malignant tumors, especially secondary sarcomata, spread through the lymphatics exactly as does tuberculosis, but they have no special affinity for the apices and they are not restricted by the septa. They spread very rapidly by continuity; thus secondary sarcomata often appear as spheres of increased density (Fig. 17). We may have a case of carcinoma which produces a mottling very much like caseous bronchopneumonia, but there are no apical fans (Fig. 16). If such a plate was caused by tuberculosis, then it would be classified under the puerile type, and we would look for a man who had been raised and had lived the greater part of his life in a sparsely settled country. The caseous pleurisies which are found in army hospitals often simulate malignancy.

FIG. 10. No. 587.—Adult type of tuberculosis with old lesion in left apex and heavy caseous bronchopneumonia in lower part of the upper lobe and scattered throughout entire lower left lobe.

Thus, the slow growth of the tubercle, the restraining influence of the septa, the exudate around infections in sensitized animals, the lymph drainage, the location of the lesion, produce characteristic densities which can be accurately diagnosed in fully 95 per cent of all cases of adult tuberculosis if doubtful cases are excluded.

Thus I have presented the early and characteristic *x*-ray lesion of the most common form of tuberculosis—the fan—and I have tried to explain why the fan. But the fan does not embrace all the lesions of tuberculosis even as seen upon the *x*-ray plate as found in adult tuberculosis, and the apical fan is never found in puerile tuberculosis.

Let us now consider briefly the remaining types of adult tuberculosis and study their densities and distribution within the lung.

Here I wish to state that chronic fibroid tuberculosis is the result of many tubercles, many tuberculous exudates and many fibroid protective reactions.

Before going further let me quote from the lecture of Dr. Bunting. "There are just three lesions in the tuberculous lung: Tubercle, exudate and fibroid protective reaction." The tubercle may have three densities: early tubercle, caseation, calcification. Exudate may have three densities: serous exudate, cellular (caseous) exudate, calcification where encapsulated. When caseation breaks down we have a cavity with decreased density. The fibroid protective reaction gives a density in proportion to the fibroid tissue produced, modified by its age. The degree of density of the various tuberculous lesions progresses in the following order. Cavity; serous exudate, early tubercle; fibrous tissue; caseation; calcification.

After the apical lesion the most common lesion of adult tuberculosis is caseous bronchopneumonia. Its *x*-ray density is a coarse flocculent mottling (Fig. 10.) It is associated with old apical lesions, usually containing cavities. It invades the lower and middle lobes and the lower part of the upper lobes, and sometimes the apex opposite to an old lesion. It frequently can be seen scattered along a branch of the main stem bronchus suggesting raisins upon a stem. It may become confluent and produce pseudo-lobar caseous pneumonia. Then it takes on a fan shape. It is probably caused by aspirating droplets of sputum containing large numbers

of virulent tubercle bacilli into primary lobules.

The size of these densities varies greatly even in the same individual, but to a greater extent in different individuals. Sometimes they are so small as to suggest miliary lesions and again they appear as a filbert.

When the *x*-ray picture is hazy and the lung appears as seen through a snowstorm, we are dealing with an acute active lesion or hemorrhage. Thus, when we see the picture of finely mottled caseous bronchopneumonia as through a snowstorm, we may suspect that we have gelatinous tuberculous bronchopneumonia or caseous bronchopneumonia complicated with an acute pneumonia. Caseous tuberculous bronchopneumonia may exist over a large area without causing any signs or symptoms, but always suggests a grave prognosis. The more acute and the more extensive the lesion the more grave the prognosis. Caseous bronchopneumonia must be differentiated from acute bronchopneumonia. The latter lesions are usually much less dense and they are not associated with large apical lesions. Also the cases of caseous pleurisy found in the puerile classification have similar lung densities without apical lesions. Malignancy also must at times be differentiated, but here again we do not have apical lesions. Always we have the clinical picture, the history and physical signs to help to solve these knotty problems, and the roentgenologist has only to describe definitely and locate the abnormal densities with or without large apical tuberculous lesions, to give the clinician his all-important clue.

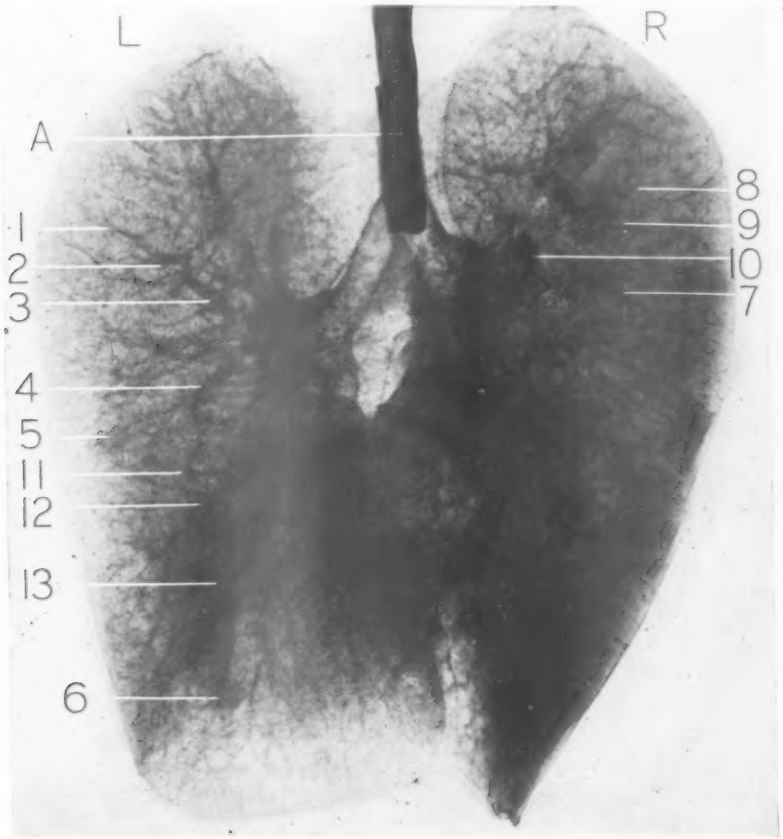

FIG. 11. No. 1096.—K. S. Illustrates heavy trunks, "peribronchial thickening" most marked in the upper left lobe, without tuberculosis. Infarct is seen in lower right lobe in area 6. (Numbers indicate sites of blocks removed for microscopic sections.)

Lobar caseous pneumonia occurs in both adult and puerile types, but old apical lesions are associated with the adult type. It is fan-

shaped and may involve a lung or part of a lung. Its size and degree of density depend upon the number of secondary lobules involved. The character of the density is homogeneous and may be found in any part of the lung. Such lesions break down and cavitate rapidly. It is the predominant lesion in "hasty consumption" which precedes cavitation.

FIG. 12. No. 1653.—Massive lesion, probably the result of syphilis because of presence of 4 plus Wassermann. Sputum was negative for tubercle bacilli on numerous examinations and the density disappeared with injections of salvarsan.

Large areas of the lung may be so involved for months without causing severe symptoms. The principal sign is flatness. The prognosis is desperate, for this lesion will surely break down and rapidly cavitate. It is called hasty consumption because, although the lesions may have existed for some time, it is often only recognized shortly before death. The *x*-ray densities of early cases must be differentiated from unresolved pneumonia and pneumonoconiosis, and the history is our best aid. Later the diagnosis from the *x*-ray plates or sputum presents no difficulties, but the clinician must ever be on his guard. Acute tuberculous pneumonia with fever simulating frank pneumonia gives a similar *x*-ray picture with less density, and the roentgenologist may be as easily fooled as the clinician if we are dealing with a puerile type without apical lesions; but if we have a definite apical lesion the roentgen examination suggests the diagnosis.

Fibrous pleurisy and pleural effusion are frequently associated with pulmonary tuberculosis. They will not be discussed in this paper except to say that a small amount of caseation is frequently found in fibroid pleurisy of the adult type, and to call attention to the very different lesions which will be described under the puerile type.

I have now reached the puerile type in this classification and repeat that it is not found with apical fans, and that its classification is based upon a study of the entire lung field.

The early puerile lesion as seen upon an *x*-ray plate shows a heavy trunk and large hilum shadows with possibly a small cap at or near the distal end of the trunk. Such foci are usually seen within the midlung zone. Sometimes enlarged pulmonary or bronchial nodes are seen (Figs. 2, 3). Unfortunately such a picture may be obtained following many diseases, and I know of no roentgen markings which are sufficiently characteristic to justify a diagnosis of tuberculosis from these *x*-ray densities. Opie and Gohn[6] have carefully described these lesions. When healed and calcification has developed they are easily recognized, but that is usually long after their clinical significance has passed. Thus, so far as I know, primary and nodal lesions in a child cannot be recognized from the plate unless they contain calcification.

Acute miliary tuberculosis deserves special consideration. I have classified it with the puerile types without fans, but realize that it does occur at the end of the disease as well, and then usually with fans. I believe that it is the result of lack of immunity or the loss of immunity. Thus we find it associated with old healed lesions in which I believe the immunity has been lost, and without such lesions I presume we have never had much if any immunity. I have specimens of miliary tuberculosis without old lesions from cases over twenty years of age, but class them in the puerile type.

The *x*-ray picture is that of fine studdings more or less evenly distributed throughout

all lobes (Fig. 6). Such a picture is very characteristic, but not pathognomonic, for some such plates cannot be differentiated from pneumonoconiosis, and we must again consider age, clinical picture, and history. Only at the end of the disease will the physical signs help. Many cases of healed miliary tuberculosis are being found by our more general use of the *x*-ray (Fig. 7). This diagnosis is only justified when the subject is well, has had no exposures to pneumonoconiosis and the calcifications can be definitely determined within some of the tubercles as seen upon the plate. The prognosis of miliary tuberculosis is very grave but cases do recover. Basal tuberculous lesions are rare. They do exist, and as they are most common in children and have no apical fans, I have classed them with the puerile types. They are pneumonic in character and sometimes have the bronchopneumonic distribution around their edge, but I have never seen the raisin on a stem distribution. They are very difficult to diagnose and I always wait for the bacillus to be found before making a definite diagnosis. This is a definite limitation and reduces the percentage of correct diagnosis, but it is safe. It is much better for the roentgenologist to locate and describe the lesion and leave the diagnosis to the clinician. Basal lesions must be differentiated from lung abscess and unresolved pneumonia. The clinical symptoms will usually differentiate it from lung gangrene. The prognosis is grave, but cases recover.

The puerile types of caseous lobar and lobular tuberculous pneumonia only differ from the adult type by the absence of apical lesions (Figs. 4, 5). The prognosis is very grave or desperate in either type, and length of life depends most upon the extent of the lesion.

FIG. 13. No. 1325.—Massive lesions due to unresolved pneumonia of influenza which clearel up slowly. This must be differentiated from massive lesions of syphilis. In this case there was no syphilitic history and patient received no salvarsan.

FIG. 14. No. 1325.—Four months later. Shows massive lesion of unresolved pneumonia now cleared.

Caseous pleurisy like miliary tuberculosis may occur in individuals over twenty. I believe that it results from lack of immunity. The *x*-ray picture is that of empyema associated with caseous bronchopneumonia without apical fans. There are various degrees of caseation within the pleura associated with fibroid pleurisy. In the adult type caseation is rare. In the puerile type caseation predominates. I have seen solid cheesy masses at the apex and base which measured 5 cm. in thickness. The extent to which the parietal pleura is involved is most extraordinary. The end is invariably fatal and rapid, but the patient neither feels nor looks

sick. Usually, if the chest is tapped, a little fluid is removed, but when aspirated a second time little is found.

The greatest helps I receive from this classification are prognosis and the differentiation of tuberculosis from other diseases —hence, intelligent treatment. *X*-ray classifications have been given by Cole,[7], Brown,[8] Waters,[9] and Heise.[10] They each have value,

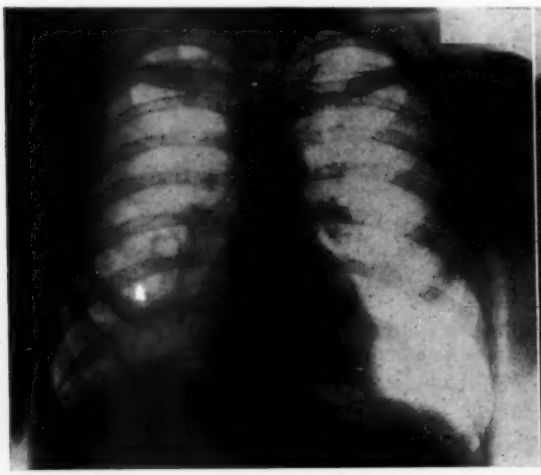

FIG. 15. No. 1313.—Bronchiectasis in right base.

FIG. 16. No. 230.—Primary carcinoma of lungs. Proven by autopsy.

but they do not help me with prognosis nor with pathological differentiation. They all deal with the extent of the lesions. This is most important after we have definitely determined the pathological character of the lesions. An old well walled-off fibroid lesion will always be a handicap, but such patients often live long, to die of other diseases, whereas a small pneumonic fan of active tuberculosis which is only seen upon the plates with difficulty usually causes an early death unless brought to immediate arrest by the utmost care.

Again, one entire upper lobe may be so contracted by scar tissue as to lie above the second rib in front and the third dorsal spine behind, and although a whole upper lobe is destroyed it would be classed as only moderately advanced. I know that this classification is neither perfect nor complete, but even in its present form it has been of great help and has enabled us to clear up many difficult problems.

THE DIFFERENTIAL DIAGNOSIS OF A FEW DISEASES WHICH, OWING TO THEIR COMMON OCCURRENCE, MUST RECEIVE SPECIAL CONSIDERATION

The first of these is syphilis of the lung. That such lesions are not uncommon is the belief of every clinician. Every large *x*-ray clinic can show cases with massive increased densities which have cleared up under antisyphilitic treatment (Fig. 13). It has always been my belief that tuberculosis was often complicated by syphilis and that both roentgenologically and pathologically the tuberculous lesions obscured the syphilitic infection. In my judgment this subject can never be closed until someone has demonstrated the presence or absence of the spirochete in the tissue. But, however that may be, we have dense lung lesions partially simulating tuberculosis upon the plates which clear up wonderfully with salvarsan. Therefore, when we have an undiagnosed density within the chest, syphilis should be thought of. To find these densities, routine *x*-ray examinations are necessary.

I have previously called attention to the frequency with which heart lesions, especially mitral stenosis, may simulate pulmonary tuberculosis, and wish to state that no examination of the lung is complete

without a heart examination and stereoscopic *x*-ray plates.

Pneumonoconiosis is deservedly receiving more and more attention all the time. There are two main forms of this—organic dust, and inorganic dust. The latter frequently suggests miliary tuberculosis and later in the disease may produce massive fans of great density, while organic dust produces large fans simulating pneumonia. Often the history and clinical condition of such patients must be ascertained before making a diagnosis.

Pulmonary infarct may closely simulate tuberculosis, especially the basal lesions, and must always be considered.

Finally, this review of over 10,000 chest examinations shows the need for more general use of the *x*-ray in studying the lungs. In tuberculosis clinics this examination should be routine, and if it were more used in our general hospitals it would not be long before many problems, such as syphilis of the lung, would be more fully understood. The greatest value of the routine *x*-ray examination lies in its ability to yield definite data in the absence of definite physical signs.

Dr. John Skavlem has been associated with me in a large part of this research, and I am especially indebted to him for arranging the illustrations and covering the bibliography.

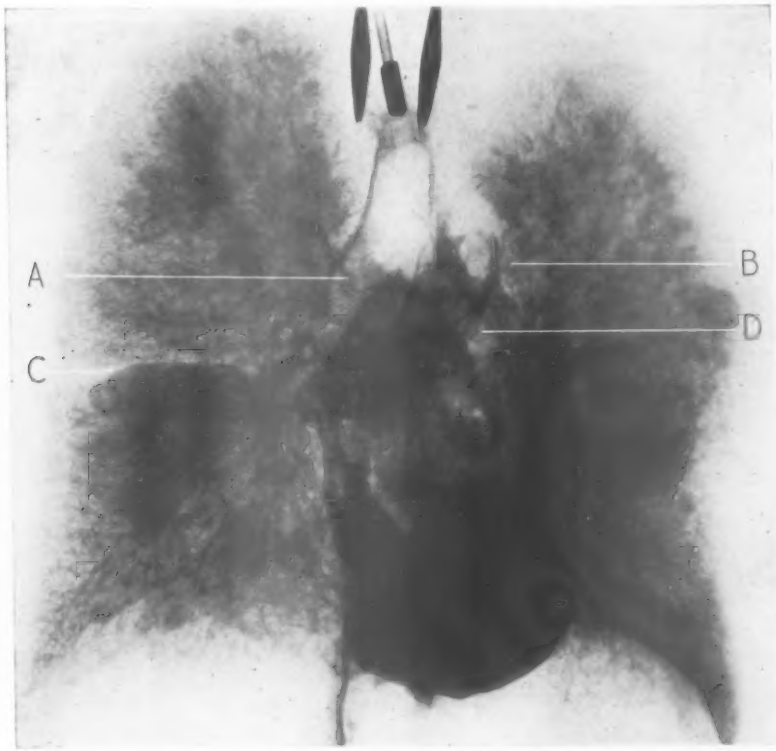

FIG. 17. No. 918.—Melanotic sarcoma of lung. Proven by autopsy.

BIBLIOGRAPHY

1. MILLER, WM. SNOW. Anatomy of lungs, *Reference Handbook of the Medical Sciences*, last edition. Some essential points in the anatomy of the lungs. AM. J. ROENTGENOL., June, 1917, iv, 269.

2. DUNHAM, KENNON. The relation of the pathology of pulmonary tuberculosis to the roentgen findings. AM. J. ROENTGENOL., June, 1917, iv, 280. A study of tuberculous lung lesions as revealed by *x*-ray plates and the value of these in physical diagnosis. 1917. Reprint *J. M. Soc. N. Jersey*. Localization of pulmonary lobes by the *x*-ray. *Med. Rec.*, June 26, 1920. The cone and collateral lymphatic circulation in pulmonary tuberculosis. *Am. Rev. Tuberc.*, October, 1917, Vol. i, No. 8. *X*-Ray Chest Manual, reprinted from the Transactions of the Fourteenth Annual Meeting of *Nat. Assn. Study & Prev. Tuberc.* Stereoroentgenography, pub-

lished by the Southworth Co., Troy, N. Y. Clinical observations derived from the examination of over three thousand chests checked by stereoroentgenograms. *Am. Rev. Tuberc.*, October, 1917, Vol. i, No. 8.

3. Opie, E. L. The focal pulmonary tuberculosis of children and adults. *J. Exper. Med.*, June, 1917. The relation of apical tuberculosis of adults to the focal tuberculosis of children. *J. Exper. Med.*, August, 1917. First infection with tuberculosis by way of the lungs. *Am. Rev. Tuberc.*, November, 1920.
   Opie, E. L., and Anderson, Hans. First infection with tuberculosis by way of the intestinal tract. *Am. Rev. Tuberc.*, November, 1920.
4. Krause, A. K. The nature of resistance to tuberculosis. *Am. Rev. Tuberc.*, November, 1920.
5. Bushnell. Epidemiology of Tuberculosis. New York, 1920.
6. Gohn, Anthon. The Primary Lung Focus of Tuberculosis in Children. J. & A. Churchill, London, 1916.
7. Cole, L. The radiographic diagnosis and classification of early pulmonary tuberculosis. *Am. J. M. Sc.*, July, 1910.
8. Brown, Lawrason, Heise, Fred H., and Sampson, H. L. The classification of pulmonary tuberculosis based upon symptoms and physical and *x*-ray findings. *Am. Rev. Tuberc.*, August, 1920, Vol. iv, No. 6.
9. Waters, Bertram H., and Amberson, J. Burns, Jr. The classification of pulmonary tuberculosis as modified by stereoscopic roentgenograms. *Am. Rev. Tuberc.*, August, 1920, Vol. iv, No. 6.
10. Heise, F. H., and Sampson, H. L. The classification of pulmonary tuberculosis with a comparative analysis of the different methods employed. Am. J. Roentgenol., March, 1918, v, 139.
11. Editorial: Tuberculosis in primitive tribes and its bearing on the tuberculosis of civilized communities. *J. Am. M. Assn.*, January 22, 1921.

DISCUSSION OF ARTICLES BY DRS. JARVIS* AND DUNHAM

Dr. H. K. Pancoast. This is a subject in which I have been very much interested for a number of years, and we have had the privilege of examining several hundred cases of pneumoconiosis, the examinations including six or eight observations. This demonstration has been particularly interesting to me because of the class of patients involved, and because the appearances have been different from those observed in any other dust inhalation I have seen. One must understand the pathology of this condition in order to interpret the roentgen findings. The consensus of opinion seems to be that the roentgen findings are due to two important things: the acute irritation resulting from the presence of dust and the appearances that may follow that, and then the appearances which follow the end result of fibrosis.

The condition of pneumonoconiosis is essentially one of fibrosis. I never have seen the appearances show so markedly as they have in these plates exhibited this morning. We have examined more potters than any other class of men, and they show more changes in their lungs than any other class I have seen, except the hard rock miners. We have examined those potters while still in the potter work, and I have examined potters who have not worked for several years on account of disability from the so-called "potters' asthma." They do not change in any respect. The appearances are always the same. Unfortunately we have never examined stonecutters, but I imagine the ordinary stonecutter would show very much these same changes unless possibly their work is more handwork and they do not use the electric drill so much. The appearances, of course, depend on the inorganic dust. The organic dust does not produce changes of any kind.

It is interesting to note the prevalence of tuberculosis in these cases. Dr. Jarvis did not say much about tuberculosis in connection with the granite-workers in the cases we have just seen. Potters, asbestos-workers and metal-grinders all show marked changes, but tuberculosis does not seem to exist in the same percentage of cases as in ordinary individuals. We do not know why it is unless because of the production of fibrosis; but it is a well-known fact that in the hard rock miners, that is, the coal miners in South Africa and the copper miners of the Southwest, tuberculosis is more prevalent. This is brought out by the Public Health Bureau, I believe. I have had the opportunity of going over a large number of their plates, and tuberculosis is more prevalent among these workers than in the average run of individuals, and it runs a rather acute course. This does not seem to be particularly due to hygienic surroundings, or lack of them. We believe there is something about the character of the dust which has some influence over the susceptibility to disease; and I imagine tuberculosis is more frequent in granite-cutters than in ordinary individuals.

Dr. Jarvis. No, we found it less prevalent.

* A roentgen study of dust inhalation in the granite industry. D. C. Jarvis, M.D. Am. J. Roentgenol., May, 1921, p. 244.

DR. PANCOAST. Is that so? At any rate, in the copper miners of the West and the coal miners of South Africa, it is quite prevalent.

We have always found, with very few exceptions, that the beginnings of the second stage of pneumoconiosis, that is, the mottled appearance, starts on the right side, around the central portion of the lung. We have always taken this to be due to mechanical causes, that is, more air goes into the right lung, the right bronchus is larger, and the dust particles, of course, are more profusely distributed. It is certainly interesting to see the distribution you have in these cases, and particularly as it is due, as I think you said, to the suppression of breathing in certain areas from pressure from the electric drill. This is, of course, another mechanical factor, and one can readily understand how certain areas of the lung might receive more dust than others because of such factors.

DR. PERCY BROWN. Many years ago, before I entered the roentgenologic field, I had occasion to make a series of visitations and statistical observations for an insurance company upon the question of pulmonary tuberculosis as between the dry-cutters (the granite-cutters) and the wet-cutters, or free-stone cutters. My comparative observations were made more in Massachusetts in the area of Quincy than in the Vermont area. Those observations, crude as they probably were, tended markedly to show a great increase in final mortality in those who worked free-stone in the wet process than those who worked in granite. In those days, at least, most of the free-stone cutters or that portion of the free-stone industry whch I observed, was shipped from Maine to Boston, and the cutting was done by hand rather than by machine, as I imagine it is done now. I should like to ask Dr. Jarvis if he has, by chance, made any comparative observations among dry-stone and wet-stone cutters.

DR. GEORGE C. JOHNSTON. I was very much interested in the remarkable recovery of some of these men, that is the change in the appearance. I shall be very, very careful in the future about making diagnoses of pulmonary carcinoma until I have made inquiries as to whether the patient is a granite-cutter, or rather I won't ask him, I will just look at his hands, and see whether or not he is a hard rock worker, because I cannot tell, and I will have some fun with any of you who think you can differentiate between early pulmonary carcinoma and some of those plates of Dr. Jarvis', because you can't do it.

The reason these men do not suffer from pulmonary tuberculosis when they get their lungs full of this dust is because of the fibrosis which follows. If these men were working in the depths of the earth, in the damp atmosphere, at a high altitude, as the hard rock miners do, they doubtless would develop tuberculosis, too; and as for the copper miners, if any of you have ever been in a copper mine, you will know that they ought to wear a diving suit. That is probably the reason why the hard rock miners of the West suffer from tuberculosis where the granite-workers do not.

Another reason why these men do not develop tuberculosis is because the sole defense of the human organism of the lung against tuberculosis is the fibrotic change produced. It would almost seem that the ideal way to cure a man of tuberculosis would be to get him a job as a granite-cutter. When I am asked to give an opinion in the prognosis of a case of tuberculosis, I can give a very fair one, and get away with it every time and base my opinion as to his reaction to his disease on the amount of fibrotic tissue present. We can have a lung riddled from top to bottom with cavities and caseations and no fibrosis in that lung, and I know the case is hopeless, whereas the entire lung can be riddled with cavities, etc., but showing an extensive fibrosis, and I know that patient will probably live long enough to infect and kill everybody in his vicinity.

DR. CARLOS HEUSER. In Buenos Aires we see many cases similar to these in people who work in grain—alfalfa, wheat, rye, etc., who carry the grain in from the fields in sacks on their backs. They are constantly breathing the dust from this grain. In many cases, small particles of the grain are inhaled into the lung, and after fifteen or twenty days, a small abscess develops, and many of them die.

DR. KENNON DUNHAM. I don't know anything that has been more interesting to me than this work of Dr. Jarvis'. It has been my privilege to go over a great many, in fact, practically all, of his plates. I want to say that while he comes to us as a rank outsider, he

certainly brings us something of the utmost value. As Dr. Johnston said just now, I will defy any of you to differentiate some of those lesions from carcinoma or sarcoma of the lung, and I will defy any of you to take some of those plates and differentiate them from pulmonary tuberculosis. Nothing have I seen which is so striking as the plates which the Doctor has brought to us at this time. If you can persuade him to show them all to you, you will not go away without learning something. Remember he is not an *x*-ray man—he is just an eye, nose and throat man, but he is living with a great problem in front of him day after day. His friends are down with this disease. And he has come forward with these plates and other examinations and shown that what was thought to be tuberculosis is probably not tuberculosis at all, and the dreaded tuberculosis in these men is not to be feared to any great extent—probably not so many, as Dr. Pancoast found in his experience, as are dying of tuberculosis in other communities.

Now let us take up the question of the dust. It has been said that organic dust does not leave any lesion. Certainly it leaves no lesion comparable to the ones we have just seen, but as our friend has said with regard to the alfalfa and other grains, they do give trouble in the lung, but the lesions are entirely different. They do not produce lesions simulating these fibrotic changes, and we must learn to divide these pulmonary dust infections from the organic dust, from those caused by inorganic dust.

Now, there is something peculiar about this granite dust that is different from anything I have seen. The anthracite coal gives an entirely different lesion, as one of our members has enabled me to learn. That particular lung we have sectioned, and found that the fibrosis was limited to small areas, and those plates simulated pulmonary tuberculosis. The locations of these fibrotic areas are exactly where we believe tuberculosis begins, that is, in the lymphatic tissue of the lung, and in the crotches of the bronchi and vessels, just where we find pulmonary tuberculosis. The pathology which underlies these cases which you have seen to-day must be very unusual, because of the catarrhal conditions which are produced, and the fibrotic conditions which are found there afterwards. I think you have in that disappearance—which is a most wonderful thing—an effort by the bronchi to get rid of this frothy expectoration, but the lymphatics must take care of the rest, so we have this movable density which comes and goes, which is different from anything any of us, so far as I am aware, have seen before. It leaves the old fibrotic changes to stay there forever.

All of the plates were not presented to you by Dr. Jarvis for lack of time, but I am sure that he will be glad to demonstrate them to any of you who will see him, and some of them are almost identical with the changes of tuberculosis.

Dr. Wm. H. Stewart. I am wondering whether Dr. Jarvis' paper does not answer the questions of some of the discussions on my paper, viz., that if granite dust in such quantities can remain thirty years in the lung and produce only a fibrosis, why a small amount of bismuth cannot remain in the lung without doing any harm?

Dr. Jarvis. I am very thankful for the way in which this paper has been received. In reply to Dr. Brown, I have never made any comparative examinations. My geographic location is such that I do not come in contact with these wet-workers.

Dr. Stewart, when I read your title, I said, "Of course, that is possible."

These densities, we think, are composed of three factors, one constant and two inconstant. The constant is the residual fibrosis. The first inconstant is the dust which is moved on by the lymphatics, and the second inconstant is what we call the edema. The edema disappears after a time, but the residual fibrosis will always show.

GUNSHOT INJURIES TO THE BRAIN

REPORT OF ELEVEN CASES WITH SPECIAL REFERENCE TO THE ROENTGEN LOCALIZATION FINDINGS*

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QUINCY, ILLINOIS

LIVING cases of foreign bodies in the brain are so infrequent that the author feels that those which passed through our large military hospitals during the late war should not go unreported. The medical literature is scant on the end results of groups of patients who have been observed for many months after the initial trauma. Twelve such cases passed through U. S. A. General Hospital No. 28, Fort Sheridan, Ill., from the time of its opening as a general hospital in the late fall of 1918 until the early fall of 1919, when the writer was discharged. He has been able to follow up eleven of them, and it now averages a little more than a year and a half since these patients received their trauma.

Before proceeding with a history of the individual cases, a few words as to the roentgen method used to localize the foreign bodies might prove interesting.

Due to the great density of the skull, fluoroscopic localization methods to determine the depth of small foreign bodies are frequently difficult. Although the writer has used the Strohl method and the simple tube-shift fluoroscopic method, in some of the cases more satisfactory results were obtained with the old tube-shift plate method. With this method lateral and postero-anterior plates were first made and then the foreign body located under the fluoroscope, a mark being placed upon both sides of the head opposite the foreign body. In each case the foreign body was located from both sides of the head, and of course in the central ray. Following this, the diameter of the head opposite the foreign body was obtained by means of calipers. Then the depth of the foreign body was determined by the tube-shift plate method, great care being taken to have the part of the head which was marked as being opposite the foreign body in contact with the plate. Since the depth of the foreign body was localized from both sides of the head, and the diameter of that portion of the head had already been determined, it was easy to have an accurate check as to the correctness of the localization findings.

Having obtained the depth of the foreign body beneath the skin, and wishing to ascertain its anatomical location, the following method was pursued. The postero-anterior and lateral diameters of the head having been obtained with calipers, a teleoroentgenogram of the head (tube plate distance 6 to 7 feet) was then made, the side of the head containing the foreign body being nearest the plate. Such a plate shows a minimum amount of distortion, the head appearing approximately normal in size if the 7 foot distance is selected. The anatomical localization is then completed by a comparative study with the sections of the Eyclesheymer-Shoemaker *Cross Section Anatomy.* (In this atlas all the head sections are shown as two-fifths the natural size. Key-Figure 2 of the Atlas contains a lateral view of the head which compares very favorably with a teleoroentgenogram of this part.) A line is drawn on the teleoroentgenogram to represent Reid's base line (from the lower margin of the orbit to center of the external meatus acusticus). This corresponds to a similar line, known as Section 10 in the Atlas. Another line is then drawn on the teleoroentgenogram, perpendicular to Reid's base line, passing through the foreign body. The distance

*Thesis presented with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

this perpendicular line extends from the line representing Reid's base line to the foreign body is measured. The distance is also measured on Reid's base line between the external meatus acusticus and the point where the perpendicular line begins. Having obtained these measurements, they are compared with similar measurements on Key-Figure 2 of the *Cross Section Anatomy*, but since these sections are only four-fifths the natural size, on the section. The foreign body then lies in a plane at right angles to this and we merely measure off its depth beneath the skin surface at this level, which gives its approximate anatomical location.

The foregoing method may appear quite cumbersome, but each step mentioned is absolutely necessary if accurate deductions are to be made. The head being oval in shape makes localization methods more difficult

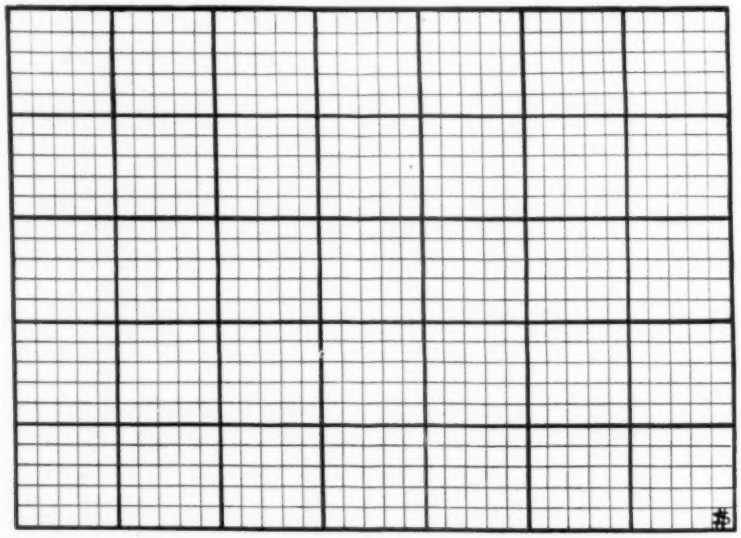

FIG. 1. Square Centimeter Scale for Eycleshymer-Shoemaker *Cross Section Anatomy*.

a proportionate reduction must be made. This is entirely overcome by drawing a scale on an *x*-ray film and then fixing it without developing. This gives a transparent celluloid scale that is very convenient. The scale is so drawn that each square is 8 mm. in size, one such square corresponding to each centimeter. Having obtained the location of the foreign body on Key-Figure 2 of the *Cross Section Anatomy*, and noting the distance it is on this figure from either the anterior or posterior extremity of the head (which of course will be in the median plane), we now turn to that plate of the Atlas which shows a transverse section of the head at that particular level.

We already know the distance the foreign body is from either the anterior or posterior extremity of the head at the level of the median plane. This distance is measured off

than when flat surfaces alone are considered. Due allowance must be made if the size of the head is much larger or smaller than that of the average size. However, since the size of the head in the Atlas is known and that of the patient has been determined by the calipers and teleoroentgenogram, little difficulty is noted. In the writer's personal experience, the diameter of the twelve adult male heads examined did not vary over 1.5 centimeters at the most. A description of the individual cases follows;

CASE I. Admitted to hospital February 17, 1919, suffering from acute cellulitis of the right hand due to striking guardhouse door while under arrest for intoxication.

White; age twenty-one; weight 155 pounds; occupation, machinist before entering the service. On February 22, 1918, in

civil service, he was shot in the head by a 22 caliber revolver; he immediately became unconscious, but in a few minutes recovered and walked to the hospital with a friend. Two weeks after entering the hospital he was operated upon, but the bullet was not found. Since being shot the only difference he has noted in himself is that he has not been so active, is not so pugilistically inclined and has occasional attacks of vertigo.

was negative. The family history was negative.

Roentgen Findings, April 30, 1919.— There is a circular bony defect about 2 cm. in diameter situated in the squamous part of the right temporal bone about 3 cm. anterior and 2.5 cm. superior to the external meatus acusticus.

There is an irregular shaped metal fragment, about 1 x ¾ x ½ cm. in diameter

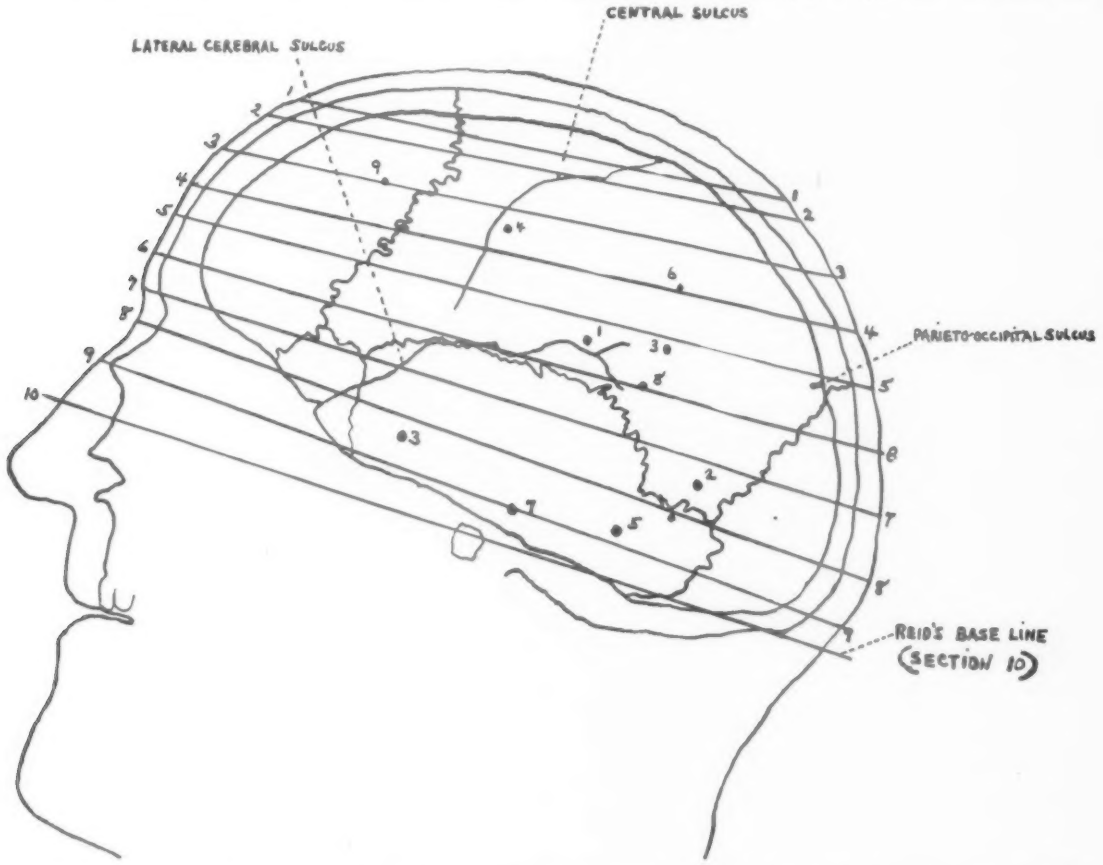

FIG. 2. Showing the location of the foreign bodies in lateral view of the skull. The number of the case is marked at the site of the foreign body and the plane in which it lies as shown in the *Cross Section Anatomy* is illustrated by the transverse lines which are numbered and called sections.

Upon examination a semilunar shaped scar was present in the right temporal region about 4 cm. anterior and superior to the external meatus acusticus. Immediately below the scar a distinct small depression was felt which pulsated. The right supratrochlear and axillary glands were enlarged and the right hand presented an acute cellulitis. Other than this the physical examination

situated 8 cm. vertically beneath the skin marks on the right and left sides of the head with the head in a true lateral position, patient lying on his side. It is therefore in the mid-sagittal plane. It is situated 1.5 cm. posterior and 6.5 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical localization corresponds to the

superior part of the splenium of the corpus callosum, probably projecting into the longitudinal fissure. Some metallic dust is seen at the lower margin of the bony defect and in the brain substance in the path to the large metal fragment. It is situated opposite the lower central part of the parietal bone about 1 cm. above the squamosal suture. The location corresponds to Section 5 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 7.5 cm. from the posterior surface in the median line.

Comment.—The interesting point concerning this case is the absence of any symptoms for fifteen months after the onset. The patient states that he never had any paralysis following the injury. It is clearly evident that the bullet passed through the entire right temporal lobe to reach its present location, yet it has not caused any symptoms, except for the initial trauma. The patient wanted to have it removed, but his reasons were purely psychological. Due to the extreme depth of the foreign body, removal was not attempted. He was observed for two months and was finally discharged from the service in May, 1919, due to repeated drunkenness and absence without leave. Mentally he appeared somewhat dull and possessed with little will power, but it is doubtful if the foreign body had anything to do with this. His education included six months of high school work.

In a letter received from this patient dated March 15, 1920, he gave a history of two distinct Jacksonian convulsions, one in May, 1919, and the other a few days before writing the letter. He also stated that at times he had vertigo, complained of a strange feeling in his head, as if it were full, and said that at these times he could not judge distance very well. This case is very interesting in that the patient after having had practically no symptoms from his foreign body for fifteen months developed a Jacksonian convulsion, which again developed ten months later.

Case II. Admitted to hospital, April 3, 1919, suffering from gunshot wounds of head and both legs, having been transferred from over-seas.

White; age twenty-seven; weight 162 pounds; occupation, machinist before entering service. On September 28, 1918, was inflicted with multiple wounds at Verdun. Following a gunshot wound of the head received at this time, he suffered from a complete right hemiplegia. He had nearly entirely recovered from this and the only symptom at the time of admission was slight weakness of the right arm.

Upon admission his general condition was good. There was a small depression in the anterior part of the left parietal region, 4.5 cm. from the sagittal suture. This was covered by a scar. There was also an old penetrating gunshot wound of the right leg, resulting in a fracture of the lower third of the tibia, which was healed and in good position, and an old gunshot wound of the upper third of the left leg which was healed. The family history was negative, but the soldier gave an alcoholic history.

Neurological Findings, May 1, 1919.—"Right-sided hemiparesis with reflex changes incident to pyramidal tract involvement of the left hemisphere; gives history of an aphasia; slight word-memory loss; is depressed over fact that he only received 20 per cent disability, and has marked emotional instability; otherwise no mental condition was found." (The final diagnosis of the Ward Surgeon was: Gunshot wound left parietal region with fracture of the skull; slight depression; healed. Gunshot wounds of right and left legs were also described.) Patient was discharged May 14, 1919.

Roentgen Findings, April 9, 1919.—There is an oval-shaped bony defect about 1.5 cm. in its greatest diameter, in the anterior-superior portion of the left parietal bone, about 5 cm. from the median line. There is some increased bone production at the lower margin of the bony defect.

There is an irregular-shaped metal fragment, about 1 x ½ x ¼ cm. in diameter, situated 5.2 cm. vertically beneath the skin mark on the right side of head, the patient lying on his left side with head in a true lat-

eral position. The surface markings correspond to the posterior-inferior angle of the right parietal bone immediately above the asterion, being 2.3 cm. superior and 5.7 cm. posterior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements.

The anatomical localization is deep in the lingual gyrus of the right occipital lobe. A very small metal fragment 1 mm. in diameter is seen in the brain on the left side near the bony defect in the path to the large metal fragment. The location of the large metal fragment corresponds to Section 7′ of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 4.75 cm. from posterior surface and 5.2 cm. from the lateral side.

Comment.—This case is interesting in that the metal fragment passed through the left parietal lobe to reach its location in the right occipital lobe. It is apparently causing no symptoms in its present location: the symptoms that were produced were due to the damage inflicted to the motor area on the left side at the seat of entrance.

The last heard from this patient was on April 12, 1920, at which time he complained of paresis in the right side together with some paresthesia. Although no Jacksonian attacks have been evident, he says, he frequently complains of great pains in his head. He also has vertigo at times and his general health is not good. In regard to his eyesight, he states: "Not very good, and tears run out of my eyes and I get dizzy." It would be interesting to know more definitely concerning the eyesight, for the location of the foreign body is in one of the visual receptive centers.

Case III. Admitted to hospital December 25, 1918, suffering from gunshot wounds of the head and right thigh.

White; age twenty-seven; occupation, tailor before entering service. On October 5, 1918, he received multiple wounds of the head and right thigh from a high explosive shell. He was unconscious for three days following the trauma, during which time his head was operated upon, and a metal fragment was removed from the thigh. Upon regaining consciousness, the left arm and left side of face were entirely paralyzed. The left leg was not affected. Both face and arm have been gradually improving and he has always been able to talk. Mentally he was not affected, except by a slight loss of memory at times.

Upon admission his general condition was

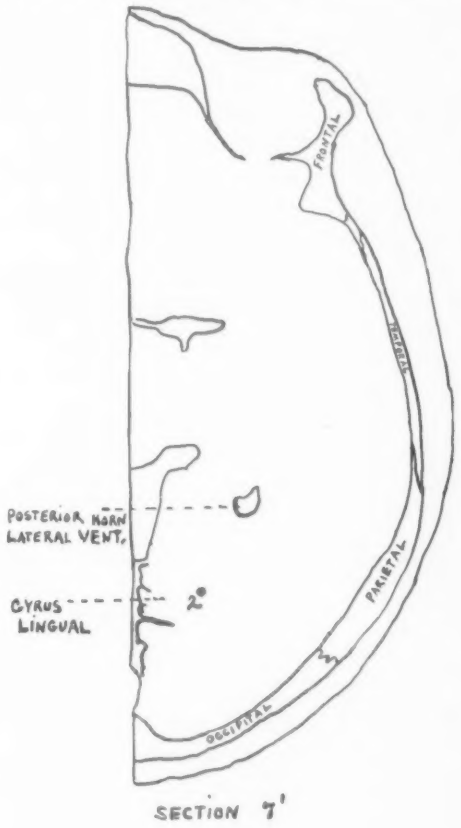

Figure 3.

good; there was a large oval depression in the upper part of the forehead on the right side which pulsates; there was an operative scar beginning 2 cm. to left of median line in frontal region and 3 cm. above supra-orbital margin. It extends circularly upward to end 3 cm. to the right of the median line. A depression is present which pulsates. The depression begins 4 cm. above the right supra-orbital region and extends to the median line. There was a mild degree of left facial paralysis with spastic paresis of left arm. Mentally he appeared clear.

Neurological Examination, March 6, 1919.—"There is some paralysis of left hand; can move all muscles of forearm but extension of fingers and rotation is slow and difficult. Reflexes spastic and some atrophy of pronators, though nutrition of arm is otherwise good. Conclusion: There is some thickening of membranes over right prefrontal area which is gradually softening."

This patient was difficult to handle. He was frequently absent without leave. His paralysis improved very much. He had several Jacksonian attacks. No attempt was made to remove the foreign bodies, because of their depth. On May 11, 1919, a bone transplant from the tibia was made to fill the defect of the skull. This was very successful.

Roentgen Findings, January 18, 1919.—There is a somewhat circular-shaped bony defect, about 3.5 cm. in diameter, in the middle portion of the squamous part of the frontal bone on the right side, extending to the mid-sagittal plane. Some bony attempt to close the gap is present.

An irregular-shaped metal fragment about 1 x 1 x ½ cm. in diameter is seen, situated 6.6 cm. vertically beneath the skin mark on the right side of the upper portion of the head, the patient lying on his side with the head in a true lateral position. The surface markings correspond to the lower central portion of the right parietal bone, being 3.25 cm. posterior and 6 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical localization is in the posterior part of the precuneus of the right parietal lobe, about 1 cm. from the mid-sagittal plane. The location corresponds to Section 5 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 5.5 cm. from the posterior surface and 6.6 cm. from the lateral side.

Another irregular-shaped metal fragment, about ¾ x ¼ x ¼ cm. in diameter, is seen situated 5.2 cm. vertically beneath the skin mark on the right side of the lower part of the head, the patient lying on his side with head in a true lateral position. The surface markings correspond to the anterior part of the squamous portion of the right temporal bone, opposite the sella turcica, being about 3 cm. anterior and 2 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical localization is deep in the right temporal lobe, opposite the middle temporal gyrus and anterior to the lower

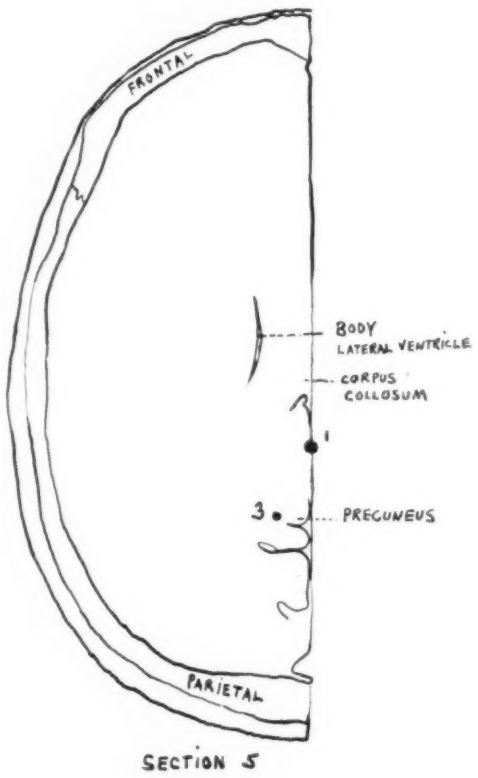

FIGURE 4.

part of the inferior horn of the lateral ventricle.

The location of the foreign body corresponds to Section 8′, Eycleshymer-Shoemaker *Cross Section Anatomy*, being 11.5 cm. from posterior surface and 5.2 cm. from the lateral side.

Comments.—Both foreign bodies passed through the right frontal lobe to reach their present situation in the right parietal and temporal lobes respectively.

On April 19, 1920, the patient reported that his left arm was still paralyzed and that

he has had light Jacksonian convulsions once a month in spite of constant bromide medication. He stated that he tired very easily and could not stand excitement.

Case IV .Admitted to the hospital April 13, 1919, suffering from a gunshot wound of the head, having been transferred from Camp Sherman.

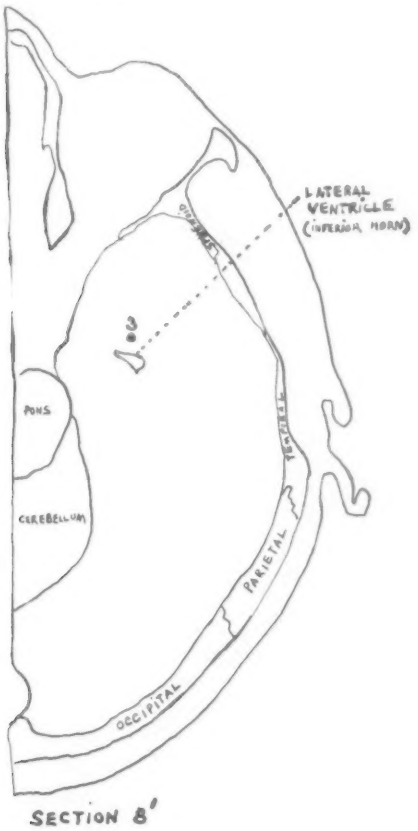

Figure 5.

White; age, twenty-four; weight 160 pounds; occupation, school-teacher before entering service. On October 5, 1918, at Verdun, he was hit in the left side of the skull by high explosive. He did not become unconscious but developed a right hemiplegia. He was operated upon shortly after and several metal fragments were removed from the wound, but the wound continued to drain. He was transferred from overseas to Camp Sherman, and on January 12, 1919, developed his first attack of epilepsy. He was operated upon January 21, 1919, to secure better drainage. Two weeks after the operation he had another attack and in five more weeks still another. On April 2d another operation was made, a piece of abdominal fat being transplanted to relieve brain irritation and dural adhesions. During this time the paralysis of the leg and face gradually improved, but the arm showed little improvement.

He was admitted on a litter, his general condition being good. There was some disturbance in speech and a loss of bone substance in the superior part of the left parietal region which was draining slightly. A right hemiplegia was present, which had improved greatly except the arm. A mild infection was present on the abdomen where the fat transplant had been removed.

Neurological Findings.—"Deep reflexes increased on the right side, exhaustible ankle clonus; Babinski on right; cremasteric reflex diminished upon the right; pupils normal; moderate spacticity and paresis of right side of face, arm and leg. There are practically all movements possible, but weak apraxia and astereognosis upon the right side is present. Can write with the left hand but misspells words. Slight association aphasia. No defect in visual field. No cranial nerve palsy. Jacksonian fits, beginning in right hand. Diagnosis: Cerebral lesion in left Rolandic area with diffuse lesion subcortical. If foreign body seems infected would remove; otherwise advise large doses of bromides."

Roentgen Findings, April 16, 1919.—There is an oval-shaped bony defect about 3.5 cm. by 2 cm. in diameter, on the left side in the situation of the coronal suture, 1.5 cm. from the median line. The defect involves portions of both the anterior border of left parietal and posterior part of the squamous portion of left side of the frontal bone.

There is an irregular-shaped metal fragment, about 1½ x ¾ x ¾ cm. in diameter, situated 6.6 cm. vertically beneath the skin mark on the left side of the head, the patient lying on his right side with the head in a true lateral position. The surface marking corresponds to the anterior central portion of

the left parietal bone, being 1.2 cm. anterior and 7.8 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The metal fragment is below and slightly medial to the posterior part of the bony defect, being about 1 cm. from the mid-sagittal plane. The anatomical localization is in the para-central lobule of the left frontal lobe. Several distinct small bony sequestra are seen in the brain substance leading to the foreign body, and at least two sequestra are seen 2 cm. anterior to the same. The location

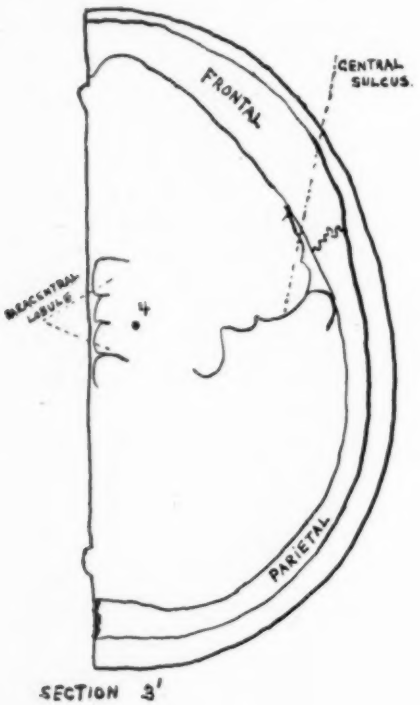

FIGURE 6.

of the metal fragment corresponds to Section 3′ of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 8.5 cm. from the posterior surface and 6.6 cm. from the lateral side. The patient's epilepsy continued to grow worse and another operation was decided upon. On May 6, 1919, the foreign body together with 6 small sequestra were removed, but the patient died three days later from an acute suppurative meningitis, following infection of the ventricles at the time of operation.

CASE V. Admitted to hospital May 19, 1919, suffering from a gunshot wound of the head, having been transferred from Fort Des Moines.

White; age twenty; weight 145 pounds; farmer before entering the service. On September 17, 1918, he was shot in back of head and buttock while trying to escape from Fort Leavenworth. He was unconscious for ten days. Following this his right arm was paralyzed. There has been an almost continuous thumping sensation in the occipital region with occasional headaches.

Upon admission his general condition was good. There was a scar in the lower right occipital region, 2 cm. to the right of the median line on a plane with the foramen magnum. A disturbance of speech was present. The general physical examination was negative except for the following neurological findings:

Neurological Findings. — "Pupils equal, regular, and react normally, but a distinct nystagmus to left was present; exaggerated knee jerks; no Babinski or ankle clonus; some atrophy of the muscles of right forearm and shoulder girdle with weakness of hand; paresis right internal rectus; dysarthria, resembling scanning speech; tongue deviates slightly to left; marked intention tremor; no sensory or thermal changes. Epileptic episodes affecting all four extremities; sudden onset, weakness and vertigo without loss of consciousness, biting tongue or lips or passing urine in the spells. Diagnosis: Insular sclerosis syndrome (traumatic)."

Roentgen Findings, May 29, 1919.— There is an irregular-shaped metal fragment, about 1 x ½ x ¼ cm. in diameter, situated 5.2 cm. vertically beneath the skin mark on the right side of the head, the patient lying on his left side with head in a true lateral position. The surface marking corresponds to the posterior portion of the squamous part of the right temporal bone, being 3.5 cm. posterior and 1.25 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical location is in the

right superior semilunar lobule of the cerebellum, about 2 cm. from the median line. The location of the metal fragment corresponds to Section 9 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 6.5 cm. from the posterior surface and 5.2 cm. from the lateral side.

There is also another irregular-shaped metal fragment about 1 x 1 x ¾ cm. in size in the muscular tissues immediately medial to the ramus of the mandible on the right side on a level with the atlas.

It is difficult to ascertain the point of entrance of the foreign body into the cranial cavity, as no bony defects are visible. There is a slight irregularity of the occipital bone on the right side about 2 cm. lateral to the foramen magnum which may be an old bone injury. In this situation some metallic dust is seen, which, however, forms a path to the foreign body in the situation of the right jaw. The only other explanation to account for the path of entrance of the foreign body into the cranial cavity would be through the foramen magnum, which is strongly suggestive.

Comment.—On April 27, 1920, this patient reported his general condition as fair. He suffers from frequent headaches and has had two severe attacks of Jacksonian convulsions in the past six months. There is some paresthesia on the right side and at times slight paresis.

Case VI. Admitted to hospital March 12, 1919, suffering from multiple gunshot wounds, having been transferred from overseas.

White; age twenty-eight; weight 150 pounds; occupation, steel construction worker before entering service. On November 1, 1918, he was hit by high explosive at Verdun. He received eleven wounds; three of head; five of right arm and shoulder; one of chest; one of each buttock and one of left ankle. Following the injury he was unconscious three weeks. The only previous history bearing on the case was that five years ago he was injured in a runaway accident and said his skull was fractured. Upon admission his general health was good, all the wounds being healed. There was a bony defect over right parietal bone about 2 cm. in diameter, and a scar was present over the right parietal region with some bony irregularity, also one in the left occipital region superiorly.

A healed wound 6 cm. long was present over the right inner arm extending over the brachial vessels to the pectoral muscles, one over the anterior part of head of humerus,

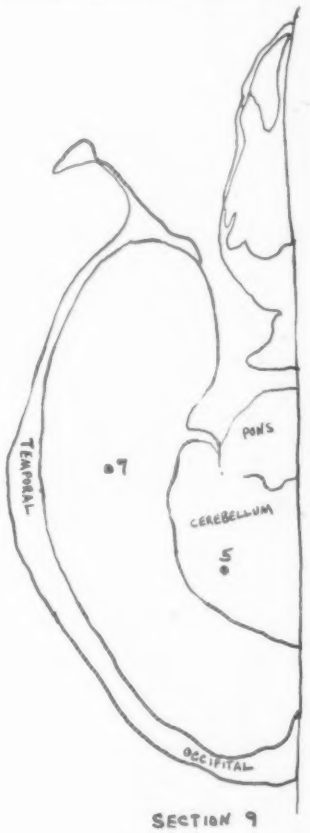

Figure 7.

lateral part of head, in posterior axillary region and edge of scapula. A wound also was present to the right of the fourth thoracic spine, there were multiple wounds of both buttocks and below left lateral malleolus; the only symptoms complained of were numbness of the outer part of the right arm and forearm.

Neurological Findings, April, 1919.—"The deep reflexes of the left side are increased more than upon the right. The reflexes of

the right lower extremity are greater than in the same arm. Cremasteric normal; abdominal reflexes diminished upon right side, especially in the upper segments. Slight incoordination in both legs and marked clumsiness in left arm. Slight astereognosis in left arm. No visual defect. Slight thickness of speech at times. Advise *x*-ray of spine over fourth dorsal. Can see no indication for cranial interference, but trouble may be remnant of old cord lesion."

The neurological findings on May 30, 1919, were: "Complete motor recovery. Stereognostic sense normal. Complete sensory recovery. Slight increase in deep reflexes."

Roentgen Findings, June 4, 1919.—There is a circular shaped bony defect, measuring 3 cm. in diameter, situated in the anterior-inferior portion of the parietal bone and anterior-superior portion of the squamous part of the temporal bone on the right side. Several small bony particles are present in the middle part of the defect. There is considerable irregularity of the antero-lateral portion of the squamous part of the frontal bone on the left side, suggesting a possible old bony injury. There is a circular-shaped old fracture line in the anterior-superior portion of the left parietal bone which extends into the frontal bone.

There is an irregular-shaped metal fragment, about ½ x ¼ x ¼ cm. in diameter, situated 2.7 cm. vertically beneath the skin mark on the left side of the head, the patient lying on his right side with the head in a true lateral position. The surface markings correspond to the central portion of the left parietal bone, being 4 cm. posterior and 9.75 cm. superior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical location of the above foreign body corresponds to the left inferior parietal lobule, being imbedded a little over 1 cm. within the brain substance. The location corresponds to Section 4 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 3.5 cm. from the posterior surface and 2.7 cm. from the lateral side.

A small metal fragment about 1 mm. in diameter is seen superficially in the skin or bone, posterior to the bony defect. Another very small fragment is imbedded in the brain substance in the path to the larger metal fragment. Three small fragments are also present in the right facial region.

Upon examination of the thoracic spine no injury was found, but a foreign body was present in the upper part of the right chest, which, however, was not localized.

Comments.—In a letter dated March 15, 1920, from the father of this patient, he

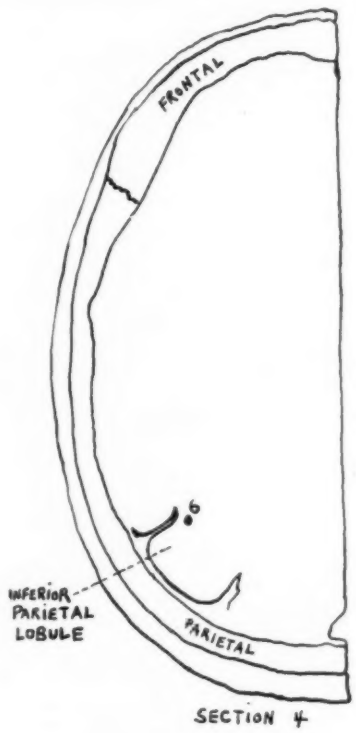

FIGURE 8.

stated that his son died on July 19, 1919, eight days after the foreign body was removed. Surgical removal was necessary due to Jacksonian epileptic attacks. This case is interesting in that the patient was discharged from the army a little over a month before the operation and gave no history of Jacksonian epilepsy and with a diagnosis of a "complete recovery."

CASE VII. Admitted to hospital, April 10,

1919, suffering from a gunshot wound of the head, having been transferred from over-seas.

White; age twenty-two; weight 165 pounds; occupation, farmer before entering the service. On July 22, 1919, he was hit by high explosive at Soissons. He remembers nothing about the accident. For a month following the accident he could not talk, had no paralysis except anesthesia over the affected side of the head and complete deafness in left ear. Later a bone transplant was placed in the skull to fill the defect but had to be removed on account of infection.

Upon admission his condition was good. There was a bony defect in the anterior lower parietal region. It measured about 2.5 cm. by 5 cm. Complete deafness in the left ear was present. There was soreness in the wound together with a discharging sinus.

Roentgen Findings, April 15, 1919.— There is an oval shaped bony defect, measuring about 4 x 5 cm. in diameter, situated in the posterior-inferior portion of the squamous portion of the frontal bone and the anterior-inferior part of the parietal bone on the left side. An irregular-shaped metal fragment about 1½ x 1¼ x ¾ cm. in diameter is situated in the cranial cavity, slightly superior and posterior to the left external meatus acusticus, which should be localized. No necrotic bone is in evidence.

Approximate location of foreign body without special localization methods: The metal fragment is about 3 cm. beneath the skin surface and is situated 1 cm. superior and posterior to the external meatus acusticus. The surface marking corresponds to the lower central part of the squamous portion of the left temporal bone. The anatomical localization is in the inferior temporal gyrus of the temporal lobe, the foreign body apparently resting on the posterior surface of the petrous portion of the temporal bone. The location would approximately correspond to Section 9 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being about 8.5 cm. from posterior surface and about 3 cm. from the lateral side.

Operation: Inasmuch as the foreign body was quite superficial it was decided to remove it. It was removed April 24, 1919. Unfortunately the patient developed an acute suppurative leptomeningitis and died four days later.

Case VIII. Admitted to hospital March 12, 1919, suffering from a gunshot wound of the head, having been transferred from over-seas.

White; age twenty-two, weight 155 pounds; occupation, farmer before entering service. On October 22, 1918, he was hit in the neck by a high explosive at the Argonne fight. He immediately became unconscious and was taken to a field hospital, where he was operated upon the following day. The operative report at that time states that the frontal bone was fractured, both frontal lobes of brain were damaged, no foreign body found, and that traumatized brain tissue and pieces of bone were removed. Following the initial trauma he suffered from paralysis of the entire right side except the face.

Upon admission his general condition was very good. There was a defect of about 5 cm. with 2 cm. of depression over the mid-frontal region, which pulsated freely. A second scar was present over the posterior part of the parietal region. Complete right hemiplegia was present which is improving. There was fibrous ankylosis of the right elbow, permitting 10 per cent of motion. Healed sores were on the right heel and coccyx. Mentally he was acute.

Roentgen Findings, March 25, 1919.— There is a large irregular-shaped bony defect, measuring 5.5 x 5.75 cm. in diameter, involving the central part of the squamous portion of the frontal bone. It reaches almost as low as the frontal sinus and the greater part of the defect is to the left of the median line. There are several very small metal fragments in the left margin of the bony defect. There is a large gaping, irregular line extending across the squamous portion of the right temporal bone, into the posterior portion of the right parietal bone to the lambdoidal suture. It does not extend to the

bony defect anteriorly. It is difficult to imagine a skull fracture gaping to this degree and the patient living, yet there are no vessels that normally pursue this course which could produce erosion of bone in this situation.

There is an irregular-shaped metal fragment about 1½ x 1½ x ½ cm. in diameter situated 2.2 cm. vertically beneath the skin mark on the right side of the head, the patient lying on his left side with head in a true lateral position. The surface markings correspond to the inferior portion of the parietal bone nearly at the squamous suture line,

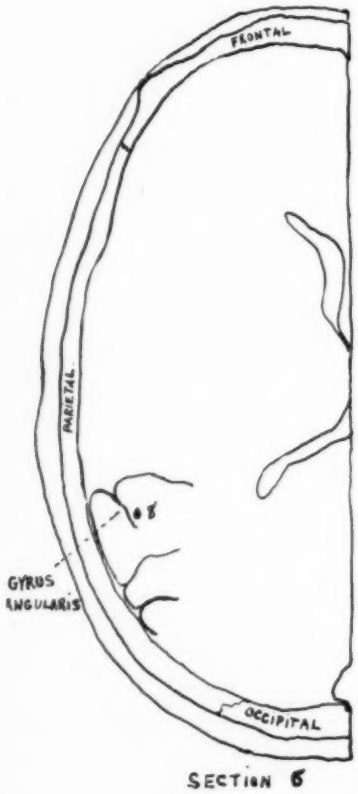

FIGURE 9.

being 5 cm. superior and 3.25 cm. posterior to the external meatus acusticus, Reid's base line being taken as a guide to these measurements. The anatomical location is in the superficial part of the right angular gyrus of the parietal lobe, being about 1 cm. within the brain substance. The location of the metal fragment corresponds to section 6 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, being 6 cm. from the posterior surface and 2.2 cm. from the lateral side.

Operative Findings.—As a result of the above roentgen findings, it was decided to remove the foreign body, inasmuch as it was quite superficial. On March 26th the skull was trephined over the localization mark, the dura split and the foreign body was removed, it being imbedded just beneath the cortex, as the localization findings recorded. The trephined bone was replaced and the patient made an uneventful recovery.

On April 17th a second operation was performed to repair the defect and depression in the frontal bone. A bone transplant from the left tibia was secured and again the patient made an uneventful recovery.

Neurological Findings, May 12, 1919.—Deep reflexes of the right side increased. Superficial reflexes as cremasteric and addominals diminished. No pathological reflexes. Slight weakness of the right side. Considerable slowness of movements of that side and some clumsiness. No sensory disturbances, no astereognosis. Cranial nerves normal, visual fields normal, discs normal. Some intentional hypertonia of arm when flexing or extending the extremity. No mental disturbance.

The patient continued to improve and when last seen, in August, the only symptom complained of was still some paresis of the right arm.

Comments.—The interesting point in this case is the extreme trauma received by the frontal lobes, and yet apparently no symptoms emanating from this destruction.

In a letter received March 13, 1920, the patient states that his general health is fairly good, although at times he is very nervous and has vertigo. There is some parasthesia in the left leg most of the time, but he has had no Jacksonian attacks.

CASE IX. Admitted to hospital April 4, 1919, suffering from gunshot wounds of head, right shoulder and arm, having been transferred from over-seas.

White; age twenty-six; weight 175 pounds; occupation, farmer before entering

the service. On November 4, 1918, he received multiple gunshot wounds (presumably from high explosive) at Verdun. Following this his left arm became paralyzed but has since recovered.

Upon admission his general condition was excellent. There was an irregular scar present in the right parietal region with slight depression of the bone. Several scars were present in the right shoulder and arm. The physical examination otherwise was negative and no symptoms were complained of.

Roentgen Findings, April 16, 1919.—There is some irregularity of the antero-superior part of the right parietal bone, which is suggestive of an old fracture, there being a loss of bone substance, but a complete bony defect is not present. Several small metal fragments are present in the situation of the fracture and should be localized.

Approximate location of foreign body without special localization methods. The metal fragment is about 2 x 2 x 1 mm. in diameter and approximately 2.5 cm. beneath the skin surface. The surface markings correspond to the posterior-superior part of the squamous portion of the frontal bone on the right side, and the anatomical location is in the superficial part of the medial frontal gyrus. The location would approximately correspond to Section 3 of the Eycleshymer-Shoemaker *Cross Section Anatomy*, but exact position cannot be stated, as definite localization was not made. An examination of the right arm showed no bony lesion, but several small metal fragments were scattered in the soft tissues. The soldier was discharged May 5, 1919, apparently recovered.

Comments.—In a letter dated March 17, 1920, this patient stated that his general health was fairly good but that he was troubled with headaches and at times has vertigo. There was some numbness in the left hand, and since his discharge he had had two Jacksonian attacks.

Case X. Admitted to hospital March 2, 1919, suffering from a gunshot wound of the head, having been transferred from overseas.

White; Russian; age twenty-seven; occupation, molder before entering the service. On November 6, 1918, in the Argonne fight he received a gunshot wound of the head. On November 23, 1918, he was operated upon.

Upon admission his general condition was good. There was a healed scar with depression over the occipital bone. The physical examination was otherwise negative and no symptoms were complained of.

Roentgen Findings, June 12, 1920.—There is an irregular-shaped bony defect measuring about 6 x 4.5 cm. in diameter in the situation of the lambda, the greater portion being on the right side. It involves both parietals and the occipital bone. A small metal fragment about 1 mm. in diameter is seen in a plane immediately posterior to the superior part of the dorsum sella and should be localized. Due to the fact that a good postero-anterior plate was not obtained, the approximate lateral depth cannot be stated. The patient was discharged May 5, 1919, apparently normal in every way.

Comments.—On April 5, 1920, this patient reported his general health as fair and that he had occasional headaches and vertigo. He also complained of paresthesia at times on the left side, but had had no Jacksonian attacks.

Case XI. Admitted to hospital June 25, 1919, suffering from gunshot wounds of head and left arm and a simple fracture of the left leg, having been transferred from over-seas.

White; age twenty-seven; weight 185 pounds; occupation, bridge carpenter before entering the service. On July 4, 1918, on the Alsace front was hit in the skull and arm by shrapnel.

Upon admission his general condition was good; a scar with some depression in the occiput was noted and also a penetrating wound of the left arm which was healed. The physical findings were otherwise negative but the soldier complained of occipital headaches and also slight deafness.

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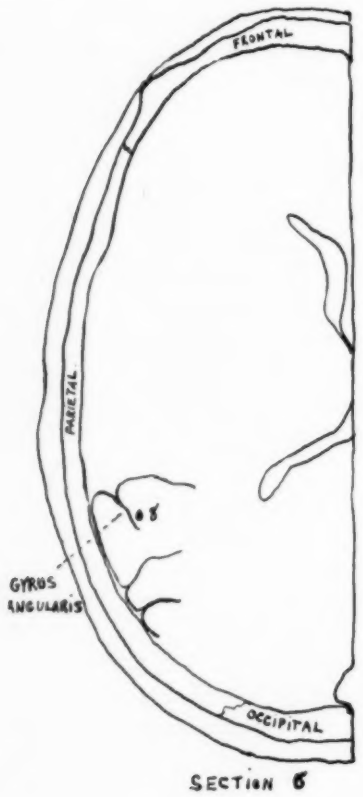

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Upon admission his general condition was good; a scar with some depression in the occiput was noted and also a penetrating wound of the left arm which was healed. The physical findings were otherwise negative but the soldier complained of occipital headaches and also slight deafness.

Roentgen Findings, June 27, 1919.—There was a bony defect in the left half of the occipital bone, including the posterior border of the left parietal. It measures about 2 cm. in diameter and the edges are smooth and regular. A metal fragment about 5 cm. in diameter is lying in the posterior fossa about 3 cm. to the left of the median line. A smaller fragment is present just lateral to the above.

Unfortunately the above foreign bodies were not localized.

Comments.—On March 14, 1920, this patient reported his general health as very poor. He suffers from headaches and twice monthly has Jacksonian attacks. He also complains of some paresthesia in his hands.

CONCLUSION

Three of the eleven cases have died. Four of the cases have been operated upon and the foreign bodies removed. Three died on the 3rd, 4th and 8th days respectively following the operation, as a result of meningitis, making an operative mortality of 75 per cent.

Of the eight living cases, seven still have foreign bodies in the brain and five of these have Jacksonian epileptic attacks. Of the two who are not so affected, one complains of great pains in his head at times and in the other case the foreign body is extremely small in size—the smallest in the series. Inasmuch as the first Jacksonian convulsion did not occur in one of the cases until fifteen months after the injury, these men may yet develop this condition, as it has been but sixteen and nineteen months respectively since they were injured. The one patient who lived following the removal of the foreign body has had no convulsions. All the cases except one complain of headaches or vertigo, usually the latter. About half of the cases have paresthesia at times in the formerly paralyzed parts, although the paralysis itself has disappeared in most of the cases. The general health of most of the patients is fairly good.

In no case does the foreign body appear to be causing any special symptom or symptoms because of its particular anatomical location. In other words, as far as we are able to ascertain, the function of that portion of the brain in which the foreign body is located is not disturbed as a result of its presence. The symptoms complained of are in general those which practically all such patients have. The special symptoms are due to the traumatized portion of the brain through which the foreign body has passed to reach its final resting place. In some cases, depending upon the composition of the foreign body, fine metallic dust can be traced from the point of entrance into the skull to the foreign body. It might also be interesting to note that in all the cases reported, except two, the men stated that as far as they recalled, they had their helmets on at the time of injury and that the foreign body evidently passed through them.

It appears to me, in view of the very large percentage of cases developing Jacksonian attacks, that every former soldier in our army who received a foreign body in his brain during the past war should be given liberal compensation. There is no certainty what may happen to the foreign body or what symptoms may develop. A man who may have a Jacksonian convulsion at any time is greatly handicapped in the pursuit of many occupations. The high operative mortality forbids surgical approach to remove the foreign body, especially if it be deeply situated. That many medical officers in our army did not appreciate the seriousness of foreign bodies in the brain is evident by the small percentage of disability that was recommended by the S. C. D. Boards for some of these men when they were discharged. I know of one case where 20 per cent was recommended and in another 25 per cent. One of these cases is now having monthly Jacksonian attacks. This is certainly a serious injustice to men who have suffered from one of the most severe injuries they can receive and yet live and who are likely to suffer and be handicapped for the rest of their lives as a result.

A MONOMETER AND FLOW-VOLUMETER FOR TRANSUTERINE PERITONEL INFLATION TO DETERMINE PATENCY OF FALLOPIAN TUBES IN CASES OF STERILITY

By I. C. RUBIN, M.D., F.A.C.S.

Adjunct Gynecologist, Mount Sinai and Beth Israel Hospitals; Visiting Gynecologist to Montefiore Hospital

NEW YORK CITY

THE present apparatus enables us to measure the quantity and the flow of oxygen or carbon dioxide gas used in insufflating the uterus to test the Fallopian tubes for patency. A manometer of the "tycos" or mercury type is combined with it, allowing for pressure reading at the same time as the gas flows. It does away with the necessity of first displacing water from another vessel at a certain rate of flow to estimate the volume of gas. This at best was only an approximate estimation.

In this apparatus the pulsating type of water displacement meter is used. It is adapted from the well-known chlorine control apparatus employed by the firm of Wallace & Tiernan for water purification by the process of chlorination.[1] The meter is of glass and is therefore non-corrodible and consists of an inverted glass siphon within a cylindrical glass meter. The latter is calibrated to a given capacity, as a rule 40 c.c. (Fig. 1.) It is hydraulic in principle, scientific, accurate and dependable. The upper end of the glass cylinder is attenuated to a narrow tube to which rubber tubing is attached to convey the gas from its source. The lower end dips down into the water contained in the large glass tube or jar of convenient size. (Fig. 2.) This glass tube or jar is provided with a rubber stopper perforated at three points, through one of which the narrow end of the volumeter passes. Two separate glass tubes pass each into the container to just below the lower limit of the stopper (Fig. 2). To one of these the pressure gauge is attached and to the other a piece of rubber tubing for the outlet of the gas. To this piece of rubber tubing the intra-uterine cannula is attached. A spring relief valve may be provided which works automatically, or in lieu of this a needle valve is placed in the course of the outlet tubing. I have found this latter to be effective and easy to handle. The spring valve is regulated to blow off at a pressure of

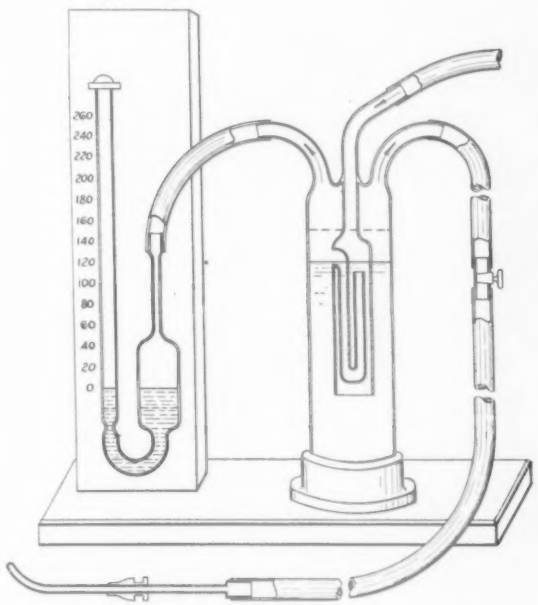

FIGURE 1.

250 millimeters of mercury. While this can be dispensed with it is an aid and is well combined with the needle valve relief. Figure 2 represents the apparatus as assembled from the parts as described. For the convenience of those who do not care to take the trouble of doing this I have had the siphon meter and glass jar with outlet and inlet connections blown in one piece and attached to a mercurial manometer. (Fig. 3.)

[1] I am indebted to Messrs. Wallace & Tiernan for the courtesy of the use of their volumeter in my work.

The operation of the siphon meter is as follows: View X shows the water level 2 in the meter at the beginning of the pulsation, and view Y shows the water level 2 just before the siphon C-G breaks at D, which completes one pulsation of the meter. When the downward flowing gas in A reaches the point D, it will rush up through the tube G of the syphon, and the bell or compartment B will refill with water up to the upper end of C. This completes one pulsation or measure of the meter, and the amount of gas delivered by this one pulsation is, of course, the capacity of the compartment B between the points F and D. The siphon meter used in my work has a capacity of 40 c.c. The amount of gas flowing may be determined by counting the number of pulsations of the meter per minute.

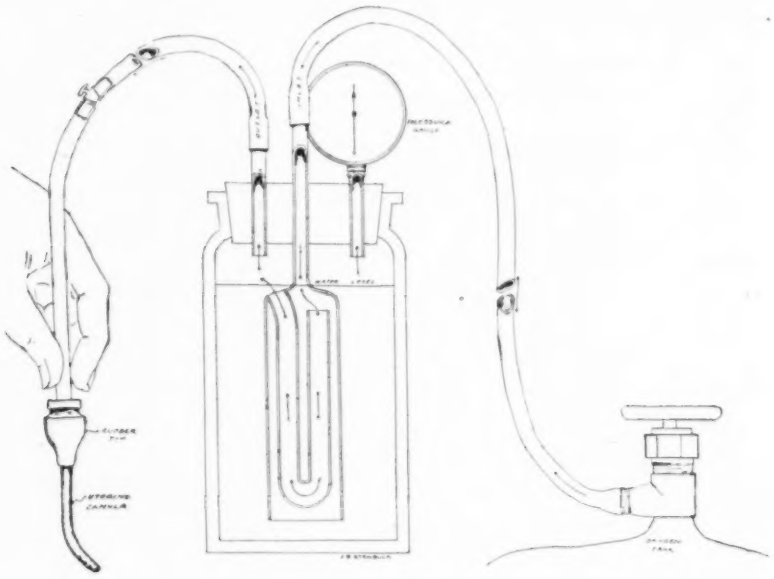

FIGURE 2.

For the purpose of determining the patency of the Fallopian tubes four pulsations delivering 160 c.c. of gas are all that are required. In thin individuals from two to three pulsations will suffice to produce in the patent cases the subphrenic pneumoperitoneum which will be clearly seen with the fluoroscope. The pressure reading is of considerable importance, and I have found that the rate of flow is best regulated previous to a rise of 100 millimeters within 15 seconds. This can be determined readily by pinching the outlet tubing as the flow is regulated till it causes a rise of pressure to 100 mm. mercury in 15 seconds time. A ratio of 10 seconds to 100 mm. will also be satisfactory; but in the non-patent Fallopian tubes, where the matter of pressure is of somewhat greater importance than in the case of patency, it is better to have the slower rate of flow, i.e., the 15 seconds to 100 mm. mercury. With this rate established (and this is done in a few seconds) the gas is allowed to pass through the volumeter and thence through the outlet tubing and cannula into the uterus. The needle valve is released until the cannula is inserted well into the uterine cavity beyond the internal os when it should be shut, making the system air-tight. Almost instantly the pressure rises at the rate predetermined and will vary somewhat in cases of patency. The pressure required to overcome the resistance of the uterus and tubes where there is no tubal obstruction to the free passage of the gas will vary between 40 and 100 mm. When reaching these points it will fall sharply or slowly or even fluctuate about them. Occasionally the initial rise of pressure in the patent tubes will be higher,

reaching 160 before it drops. The significance of this will be taken up in another communication.

In the non-patent tubes the pressure rises steadily to a point well beyond 200. It is not necessary to carry this beyond 250 mm., because in all the cases so far examined this pressure was found to indicate occlusion. When, as occasionally happens, the gas will go through after reaching a pressure of 200 mm. mercury, that case may for practical purposes be considered sterile, because the obstruction is nearly complete. But it must be borne constantly in mind that the rate of flow must not exceed in rapidity that of 100 mm. in 15 seconds. I have used a slower rate of flow in many cases, particularly in the non-patent cases where it is desirable to check up the finding of the first examination. This can be done during the same sitting when the flow is retarded, so that it requires 20 to 30 seconds to raise the mercury column to 100 millimeters.

While the apparatus has been assembled for the transuterine peritoneal inflation to determine the patiency of Fallopian tubes in cases of sterility, it may be used to advantage in the direct transperitoneal inflation by abdominal puncture. The pressure gauge is in the latter case not so important, but it provides an accurate volumetric measure of the gas introduced into the peritoneal cavity. The flow being visible through the volumeter it may be stopped at any point when a desired amount has been given. The number of pulsations would have to be increased to say, 12 times 40 c.c. or 25 times 40 c.c., depending upon the amount of gas that one desires to introduce into the peritoneal cavity.

Thus far the apparatus has been used in 225 cases out of a total of 350 insufflations and has given complete satisfaction.

I am glad to acknowledge my indebtedness to Dr. Reuben Peterson for many valuable suggestions in developing the finer details of the technique and in checking up my work. He has had the happy thought of combining the transuterine with the transperitoneal methods of producing artificial pneumoperitoneum, and in his hands the method has become established as a valuable adjunct in gynecological diagnosis.

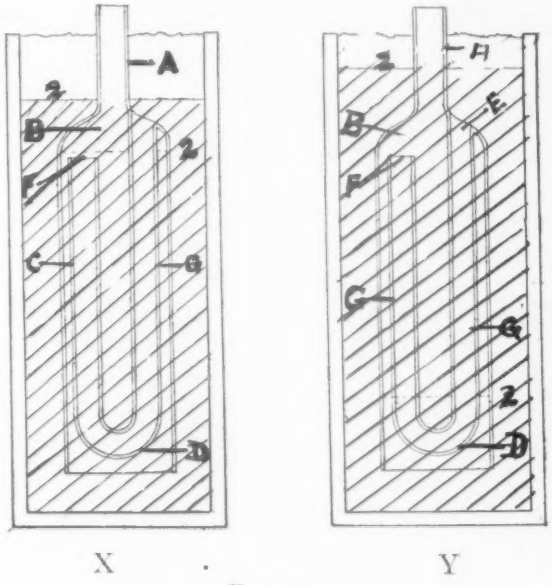

FIGURE 3.

MULTIPLE OSTEOCHONDROMATA*

By BERNARD PIERRE WIDMANN, M.D.

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IF we were to stop after a careful review of the scant American literature on multiple cartilaginous exostosis, we should probably conclude that the condition is obscure and rare.

Ehrenfried[1] in 1916 contributed a most complete and detailed review of this subject, comprising a study of reported cases largely from the English literature, in which he demonstrates clearly that the condition is not rare, but a rather common occurrence.

FIG. 1. True bony union between lower ends of radius and ulna. Thickened and shortened lower end of ulna.

Whether it is considered unimportant, or common, or obscure, every case presents some unusual or striking characteristic, either as to history, skeletal deformity, or concomitant sequelae. This should stimulate interest and study of these unusual phenomena as to their nature, extent, and frequency of occurrence, and they should be of particular interest from a roentgenological point of view. There has been no common accepted standard of terminology. Virchow established the name of Multiple Cartilaginous Exostoses. Hereditary Deforming Chondroplasia, Multiple Cartilaginous Exostoses, Ossified Diathesis, Multiple Cancellous Exostoses, Rachitiform Enchondrosis, Chondral Dysplasia, and Multiple Congenital Osteochondromata, are names that have been applied to this condition. It is a definite pathologic entity due to an anomoly in ossification of temporary cartilage. There is as yet considerable variance of opinion as to its etiology. Ehrenfried characterizes the conditions as the occurrence of multiple, more or less symmetrical cartilaginous and osteocartilaginous growths, within and on the the skeletal system, generally benign and resulting from a disturbance in the proliferation of the bone-forming cartilage.

Percy[2] investigated 113 descendants of a case, of whom 26 were affected, 73 not affected, and 14 unknown. Of those affected 22 were males and 4 females. Transmission through affected males and females was about in relative proportion of those affec-

*Thesis presented with application for membership in THE AMERICAN ROENTGEN RAY SOCIETY.

ted, but in two cases the disease was transmitted through unaffected females. Familial cases have been reported by Gibbony,[3] Oberndorf,[4] Boggs,[5] Ochsner and Rothstein,[6] and Ashhurst.[7]

Endocrine derangements, trophic disturbances depending on disease of the central nervous system, the theory of infection because of the fever and rheumatic pains in a few reported cases, are theories that have been advanced from different sources as possible causes of multiple osteochondromata. Pissovy found tuberculosis in forty of one hundred cases. This association may be significant. Hunter emphasized its constitutional nature. Volkmann and others have assigned rickets as the cause. Paget recognized it as an ossific diathesis due to some morbid condition of the blood. Several German writers have recognized it as a disturbance of growth. Keith, at a meeting of the Medical Society of London, January, 1920, insists that the disease be removed from the category of tumors and classified among the disorders of growth under the name suggested by Morley Roberts — "diaphyseal aclasis."

If John Hunter's teaching of bone growth be correct, i.e., that new bone is laid at the extremities of the shaft in the diaphyseal lines in the first process, and that in the second process which Hunter named the "modeling process," the cancellous bone laid down is rebuilt, trimmed and gradually converted into an architectural part of the shaft, then in diaphyseal aclasis, Keith concluded, the "modeling process" is arrested; hence between the properly formed part of the shaft and the epipyhseal end there is interpolated an irregular cylinder of imperfectly modeled bone on the surface of which there are several outgrowths. The disturbance is greatest where the growth is most vigorous and prolonged.

In the following case no hereditary history was obtainable beyond the immediate family. Master H. C. White (thirteen) was referred to the Neurological Department of the Polyclinic Hospital to discover if possible the

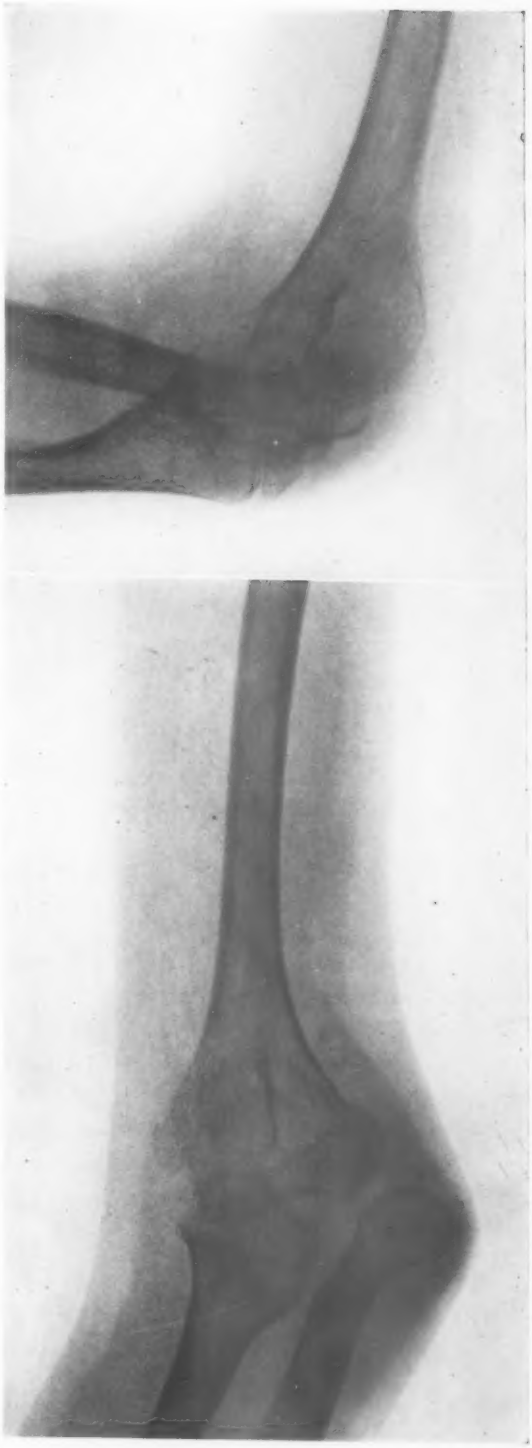

FIG. 2. Dislocation probably due to overgrowth of head of radius.

cause and cure of the multiple body tumors.

Chief Complaints. Prominences and deformities about wrists, knees, ankles, scapulae and clavicles.

Family History. Mother living and well at fifty-two. Father living and well at fifty-seven. Five brothers and two sisters all living and in good health.

Previous History. Youngest child, no history of tuberculosis. No cardiac renal disease nor any chronic diathesis; normal birth; adenoids in childhood. Bony tumors about joints first noticed about the age of four.

FIG. 3. Shortening of tibia.

Present History. Bony prominences about both wrists, ankles, knees, scapulae and clavicles. No pain or discomfort of any kind. No soreness, no tenderness, no evidence of inflammation.

Physical Examination. Height 4 feet 8 inches, weight 82 pounds. Patient a cheerful, alert, intelligent-looking boy. Long loose extremities, good free and easy function of all joints. Hyperextention of 10 to 15 degrees at elbows. Upper extremities seem slightly shorter than normal. Moderate hypophysis, prominent bony enlargements at wrists, knees, and ankle joints, over the clavicles and inferior angle of left scapulae. No apparent enlargement of the thyroid. Von Gräfe's and Stellwag's signs present. Tonsils enlarged and the cheesy material exuded. Wide area between uvula and post-pharyngeal wall suggested adenoids. Aortic second sound increased over other sounds of heart.

Blood pressure: Systolic 100, Diastolic 60. Urine, negative. Wasserman negative. Von Pirquet, negative.

The roentgenographic findings in this case are very interesting. In general there is a disturbance in the ends of all the diaphyses of the long bones. This involves even the ribs. None of them are absolutely normal. The disturbance varies from a slight thickening to actual tumor formation 1½ inches in thickness. All of these tumors have the characteristics of bone; that is, they consist of cancellous tissue, more or less regularly arranged, with no destructive effects, and none of the appearances that occur in true tumors. The lower extremity of the right humerus is shortened, thickened to twice its normal diameter and is associated with a number of separate nodules. In the left wrist the exostoses extend between the lower extremity of the radius and ulna, and are apparently united with a true bony union. Even the left ulna is considerably shortened in comparison with the radius, probably due to an interference with the normal growth of the diaphysis in this bone. In the right elbow there is apparently shortening of the ulna with considerable thickening of the upper extremity of the ulna and comparative overgrowth in length of the radius, which gives a dislocation. At the lower extremity of the tibia and fibula of both legs there may be shortening of the tibia and corresponding elongation of the fibula, probably due to this overgrowth. There are exostoses also about the diaphysis of the os calcis.

The following three cases were taken from

Dr. Pfahler's records and the examinations were made on January 27, 1903, at the request of Dr. J. Hendris Lloyd: the father, T. O'B., age forty-two; the son, J. O'B., age ten, and the daughter, E. O'B., age thirteen. There were no other children. All of these three cases were examined and all of the long bones of the bodies, including the ribs,

FIG. 4. Elongation of fibula.

showed exostoses growing from the ends of the diaphyses.

There is nothing in this report that distinguishes these cases as unusual in type and skeletal deformity from those on record. The deduction must follow, however, that the condition must be classed as a distinct abnormal pathological entity. A study of the characteristic finding is fascinating and the roentgenologists should ferret out their records and classify any data from their histories and physical examinations that may possibly serve as a working basis in determining the etiological factors and possible methods of treatment. While these bony growths are benign they may become malignant. Several unusual anomalies have been recorded. Oschner and Rothstein [6] report a case of multiple exostosis with an intraspinal endostosis pressing on the spinal cord causing incoordination of the upper and lower extremities with improvement after surgical intervention. Clark and Atwood found an exostosis growing from the sella turcica in a case of multiple exostosis causing pressure in the pituitary body.

Oberdorf[4] observed a boy of nineteen who presented a typical clinical picture of acromegaly.

It would seem, therefore, that this is undoubtedly a constitutional disease. It has to do with the growth in length of the long bones and must involve a disease of the organs controlling such growth, and would seem, therefore, to be primarily a disease of the endochrine system. There is certainly a hereditary tendency in some instances.

BIBLIOGRAPHY

1. EHRENFRIED. *J. Am. M. Assn.*, 1915, Vol. xiv.
2. PERCY, N. M. Multiple chondro-osteoma. *Surg., Gynec. & Obst.*, 1915, xx, 619.
3. GIBNEY, V. P. Multiple exostoses. *Med. Rec.*, N. York, 1875.
4. OBERNDORF, C. P. A case of multiple exostoses coupled with syringomyelia, *N. York M. J.*, 1910, xci, 479.
5. BOGGS, R. Multiple congenital osteochondromata with degeneration of cranial nerves and muscular dystrophy. *Johns Hopkins Hosp. Bull.*, 1913, xxiv, 210.
6. OCHNER AND ROTHSTEIN. Multiple exostoses including exostoses within spinal canal, with surgical and neurological observations. *Ann. Surg.*, 1907, xlvi, 608.
7. ASHHURST. Multiple cartilaginous exostoses with notes of nine hitherto unpublished cases. *Ann. Surg.*, 1915, lxiii, 167.
8. CLARK AND ALWOOD. *N. York M. J.* 1907, lxxxvi, 97.

SUPER-RADIATION AND DELAYED REACTIONS*

By ALBERT SOILAND, M.D., F.A.C.S.

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FOR want of a more suitable term, the writer will designate the new roentgen ray deep therapy method as super-radiation. The potentiality of this highly specialized form of deeply penetrating ray energy is of more than ordinary interest. To you who have followed the life history of our specialty and have had an intimate and personal share in its development, the importance of super-radiation to medicine is immediately apparent. To you, too, its many difficulties are not unknown. There are many, however, who will perhaps not readily grasp the fact that the path to this fascinating new therapeutic field is beset by many dangers, and that he who travels its course must assume grave responsibilities. It is not my intention to discourage investigation. Rather I am filled with enthusiasm by the knowledge that we are on the verge of obtaining from the *x*-ray tube, gamma radiation in unlimited amount. Realizing it, we must approach this work with consummate care, and in our desire to make progress, make haste slowly. The necessity for this care is obvious, and need not be emphasized before you, except to call your attention to its urgency.

The fact that very soon electrical transformers with a capacity of 200 kilovolts will be available and that tubes to carry this stress successfully are now being made, is of the greatest possible interest to us. We must prepare ourselves to make proper use of this apparatus, which should not be a severe task if we profit by the lessons of the past.

Consider, first, that you are increasing your voltage 100 per cent and what that implies with your present equipment and what you now consider safe protection to yourself and your patient from the high tension line. Second, the probabilities are that even with your present lead-covered operating booth and lead-glass-covered tube holder, you are none too well protected. What, then, will you require for protection against such super-radiation as is here indicated? Third, and of greater importance, what of the primary and secondary reaction of prolonged gamma radiation upon your patient?

To solve the first problem presented, no doubt manufacturers will see that whenever possible only non-conducting materials will enter into the appliances produced. Then the radiologist should personally superintend the installation and assure himself that all air-gaps between electrical points anywhere in the room exceed by at least one-third distance the capacity air-gap between the sparking points of the transformer. To fulfil this requirement will necessitate at least one half more space than that occupied by the average treatment installation of to-day. Again, the patient's table, the tube stand, and all parts of the apparatus which carry the high line should be of wood or similar non-conducting material, and no metal of any description should come in contact with the patient. An efficient automatic and fool-proof circuit breaker should also be in the line.

These provisions, with the line switch brought into proper position and correctly wired, should insure a reasonably safe installation against accumulated high potential discharges.

Turning to the protection of the operator, I do not hesitate to emphasize an often repeated statement that the average roentgenologist is practically unprotected from the secondary *x*-radiation, and only very slightly protected from the primary *x*-radiation. I have seen men all over America working with 90 kilovolt tube discharges, and the only shield between them and the functionating tube, 4 feet of air space and a single

*Chairman's Address to the Second Annual Meeting of the Western Section of THE AMERICAN ROENTGEN RAY SOCIETY, at Portland, Ore., May 27, 1921.

4 by 6 foot panel, containing a small sheet of lead-glass for a window, and 1/32 inch thick lead over the rest of the panel. With the advent of the forthcoming super-machine, a law should be passed which will compel every radiologist thoroughly to protect himself, his operator, and his patient by every known means against present and future *x*-ray dangers. It should be determined by competent electrical research just how much lead and distance screening is necessary for complete protection, and then every institution should be equipped in conformity with the specifications laid down.

We will now approach the third and most important problem. The patient's status with respect to immediate protection against primary as well as the problem of delayed secondary reactions must be most carefully considered. Immediate protection, as referred to in the preceding sentence, is limited to primary and secondary radiation from the tube itself, as it may reach any part of the body, not necessarily in the field of treatment. The ordinary lead-glass cover bowl as used to-day is not sufficient, but this can be covered by lead-rubber composition cloth sufficiently heavy to serve the purpose adequately. Protection from the secondary direct radiation into the treatment field is an entirely different matter, and one which we cannot so readily control. It is to this I call your most respectful attention, as here we shall have to deal with the very unpleasant phenomenon which not infrequently follows, known as a delayed roentgen reaction. We have met with unfortunate results, some of us more frequently than others, in obtaining unexpected *x*-ray reactions from the mild to the gangrenous varieties, even in cases where all the provisions in conformity with our supposed table of safe dosage had been carried out. Such unfortunate reactions have been observed appearing as late as three years from the date of the last *x*-ray treatment, and giving no sign of their insidious approach in the interval. This is not theory, but a stubborn fact, for I have personally seen several cases in which two or three years after radiation for uterine conditions, the abdomen has taken on gangrenous changes, too extensive for surgery and uninfluenced by any treatment. You know the result.

Are we to assume, then, that with the inauguration of super-radiation the dangers from delayed radiation will be increased twofold? As has been already pointed out in a previous paragraph, the dangers from secondary tube radiation or secondary rays originating within the tube proper are increased, but it is by no means certain that this rule holds good in the secondary ray phenomena following direct radiation upon and within the human body, when this is administered through metallic filters of great density, admitting only a homogeneous gamma radiation. It must be firmly fixed in mind that we are now considering radiation which up to the present time has been available only in small amount, and whose remote effect, consequently, sufficient time has not yet elapsed to determine. It would appear to the writer that, inasmuch as untoward *x*-ray reactions occasionally follow even the most careful *x*-ray technique, super-radiation will in all probability increase in proportion to its greater volume whatever sequelae may be induced by this enormous increase of radiation units. On the other hand, we may well conclude that with voltages of 200 kilovolts and plus, no alpha or beta ray effects need be seriously considered, nor is gamma radiation *per se* a source of danger to cell life, but only when releasing its energy of radiation under prolonged exposures does it become a serious problem. The effects of super-radiation, therefore, are as yet only partially visualized.

We are all familiar with the distressing immediate effects of a massive dose, beginning with nausea, then vomiting, shock, and prostration, the severity of which varies in proportion to the length of time the rays are applied and the particular radio-sensitiveness of the patient. The question we may well ask now is what future metabolic or destructive changes are to be anticipated where a definite area of the human body has been invaded by eight to ten hours of super-radiation? The comparatively brief time — two years — in

which such exposures have been maintained, is, in the writer's opinion, far too short to determine end-results, either curative or pathological. With the knowledge before us that greater time is necessary to ascertain delayed pathological reactions even in the ordinary technique of to-day, would it not be wise to desist for the time being from this heroic method and adopt a safe middle ground position, until we have been able to study late cases and collect sufficient data for tabulation? In the meantime, let us enter firmly but cautiously our new battlefields, with the fervent hope that we shall succeed in mastering this potent force without the necessity for the humiliating admission later that we have, peradventure, been instrumental in producing an end-result far more terrible in its consequences than the dreadful disease we are attempting to conquer.

ROENTGEN RAY TREATMENT OF ACNE VULGARIS*

By. J. M. MARTIN, M.D., AND CHAS. L. MARTIN, M.D.

DALLAS, TEXAS

ACNE vulgaris is a very general disease and appears in all parts of the country and among all classes of people. It is pretty equally divided between the sexes and is most common from the age of thirteen to that of thirty-seven. A good many thus afflicted do not apply to physicians for treatment, but content themselves with the use of patent medicines, soaps and creams. A large number of girls in the cities frequent the beauty parlors where steaming, massage, comedo extractors, violet rays, and ointments are freely used. Others apply to their family physicians who advise diets, mineral waters, laxatives, various kinds of ointments and washes. To the latter the dermatologist usually adds the curette, the lancet, vaccines, the Kromayer lamp and in some cases *x*-rays.

Under the simplest treatment most cases appear to improve for a time, only to relapse. Some appear to run a definite course and undergo complete resolution, as though the disease were self-limited. A considerable number of these cases, after going the rounds for several years without relief, finally in desperation come to the roentgenologist as a last resort.

It has often been argued that radiotherapy is a more or less dangerous agent and should not be employed except in severe types of acne. The comedo and pustular stages of the less severe types are unsightly and are especially objectionable to women who wish to keep their skin free from the scars and lifelong disfigurement that result from pitting and cicatricial contraction in the skin not unlike the scars from smallpox. We feel that such types should receive the benefits of irradiation early in the disease.

In this connection it cannot be denied that all or nearly all potent therapeutic measures are dangerous in unskilled hands, and the *x*-ray is no exception to this rule. Accidents and unfavorable reactions resulting from treatment given during the evolution of a system of accurate roentgen therapy should not prejudice the physician against the use of so valuable a curative agent.

The etiology of acne has for years been a moot question. In an editorial in the *Medical Record* in 1896 it is stated that "acne is an inflammation of the sebaceous glands and adjacent tissue." The causes are divided into the three following classes: (1) The over-production of sebum; (2) impediments to the escape of sebum, and (3) irritation of the glands by foreign matters, such as pyogenic organisms from the outside or drugs eliminated through the glands. The same writer quotes Dr. R. A. McDonnell[1] as saying that "the causative factors of acne may be increased to eighteen or twenty," from which the writer draws the conclusion that "acne may be produced by almost any-

*Read at the Second Annual Meeting of the Central Section of THE AMERICAN ROENTGEN RAY SOCIETY, St. Louis, Mo., Feb. 21, 1921.

thing from indigestion to a state of exalted self-consciousness." Recent authors have added little.

Acne is characterized by several stages of development rather than by distinct types. The papules may remain as such for a considerable time and then undergo resolution, or they may increase in size until they become tubercles, or suppuration may take place within the sebaceous glands and the hair follicles, thereby producing pustules. Healing of the pustules produces atrophic scars, pitting, and cicatricial tissue in the skin.

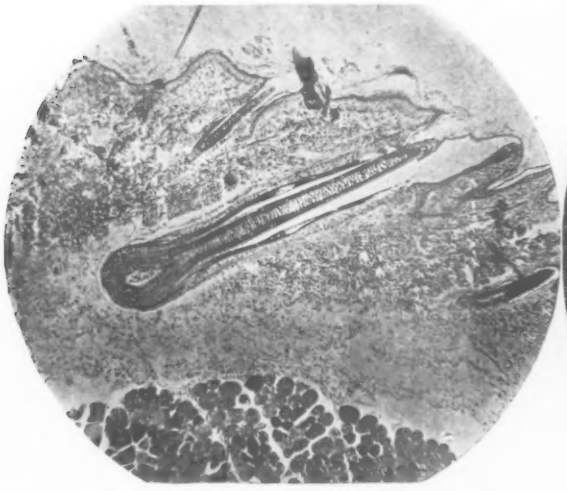

FIG. 1. A portion of normal skin from the abdomen of a guinea pig showing a hair follicle to which is attached a sebaceous gland high up on the right side as indicated by the arrow. The sebaceous glands in this region are all small.

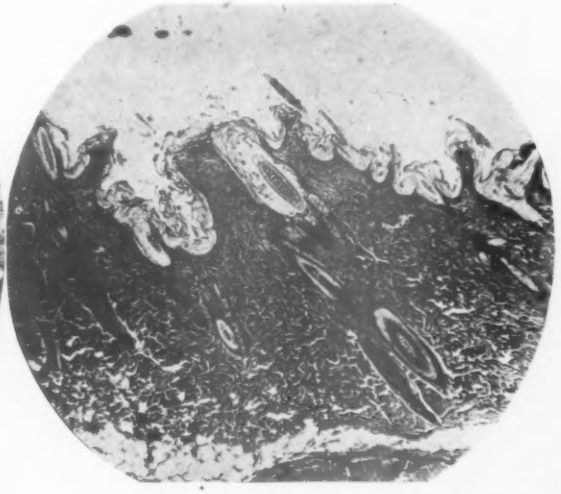

FIG. 2. A portion of skin removed from the abdomen of a guinea pig two days after the administration of an erythema dose of *x*-rays to this region. The arrows indicate sebaceous glands which have a normal histological appearance.

Most investigators believe that the earlier lesions, that is, the small papules, result from the infiltration of plasma cells, giant cells, mast cells and fusiform cells about the outlets of the sebaceous glands. As the infiltration continues and the entire gland and later the hair follicle are surrounded by the infiltrating cells a large papule and finally a tubercle is formed. At times several glands and follicles may be involved in one lesion. When suppuration sets in leukocytes appear and the glandular structure is destroyed. In some cases the destructive process also involves the hair follicles and small dermic abscesses may be formed. Semon,[2] in a recent article, mentions the fact that periglandular fibrosis occurs which is often exceedingly dense. He feels that this fibrosis protects bacteria lying within the glands from the action of vaccines.

The diagnosis of acne should not be difficult. The affection most likely to simulate acne is acnitis which has been called "Disseminated Follicular Lupus," "Acne Rodens," "Acne Necrotica," etc. Ketron[3] in an excellent article has pointed out the following points characteristic of acnitis as distinguished from acne: (1) Its resemblance in color and general aspect to lupus tissue: (2) its indolent and non-inflammatory course; (3) its unsusceptibility to ordinary acne therapy. From a careful histologic study of tissue affected with acnitis, Ketron[3] thought he had located the beginning lesions. Nodules of infiltrating cells lay in the lower half of the cutis and were in no way connected with the sweat glands, hair follicles or sebaceous glands, but lay along the blood-vessels. Ketron[3] believed that the primary lesions of acnitis originate in the small blood-vessels at various depths in the cutis.

In reviewing the literature on the roentgen treatment of acne we were surprised to find as far back as 1896 rather detailed reports of cases that were successfully treated. In spite of the fact that a good many ugly results indicated, according to their statement, that the *x*-ray was the most effective and reliable of any method of treatment known up to that time. In 1908 Sutton,[9] after discussing other methods of treatment,

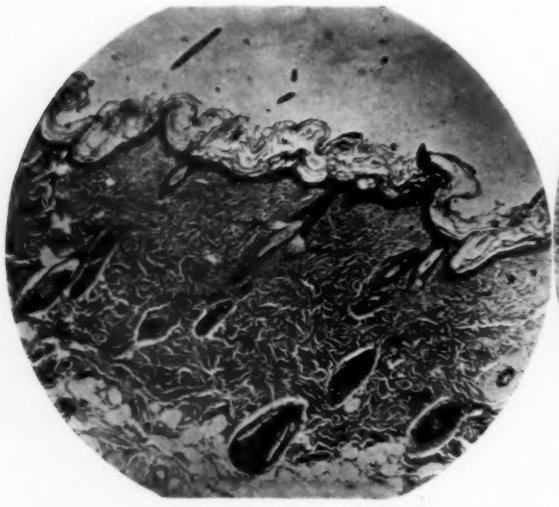

FIG. 3. Skin removed four days after exposure. In the following illustrations, the arrows indicate the location of the sebaceous glands.

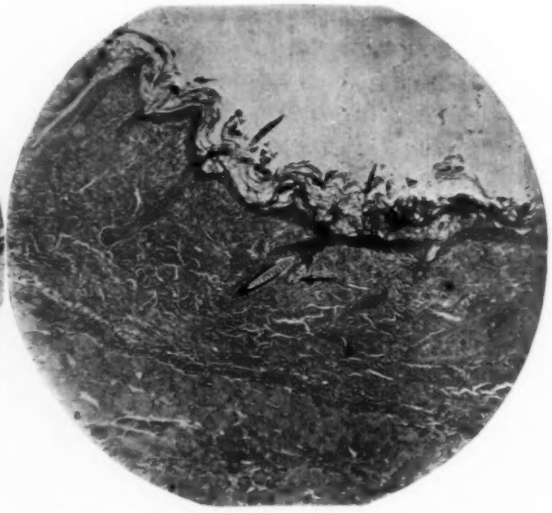

FIG. 4. Skin removed six days after exposure.

x-ray burns occurred during the early days of roentgen therapy, many roentgenologists persevered in their efforts and obtained surprisingly good results. Viewing the rise of roentgen therapy in the light of our present knowledge, we are forcibly reminded that "fools rush in where angels fear to tread." Following along untrodden paths, without accurate means of dose determination, the wonder is that accidents were so rare.

In 1896 Ullman[4] reported the cure of a case of acne treated by *x*-rays. In 1898 Gautier[5] treated three cases that resulted favorably after other methods had failed. In 1900 Schiff[6] and Freund of Vienna used rather heroic doses of *x*-rays in the treatment of acne, with gratifying results. In 1902 R. R. Campbell[7] reported fifteen cases of acne treated by roentgen therapy with universally good results. His patients ranged in age from fifteen to thirty-seven years, seven being over twenty-four and three over thirty. In 1904 Toroeck and Schein[8] reported seven cases of acne vulgaris treated with *x*-rays. Their stated that *x*-ray treatment gave brilliant results at times. In 1912 Fisher[10] had treated twenty-one cases with uniformly good results. In 1917 Hazen[11] had treated forty cases. Twelve cases were cured; fifteen cases were improved.

Up to the time that we abandoned the use of the induction coil and gas tube in superficial therapy, we had treated thirty cases of acne in various stages of development. While we had worked out a dependable technique and tried to keep the factors as constant as possible by following a standard routine, all men of experience know that the gas tube is a variable quantity and that it is next to impossible to repeat the dosage in a given case or to duplicate results in a series of cases. Because of these facts it was necessary to stay well within the zone of safety for the average case. In all lines of medical and surgical endeavor the lack of an absolute standard of technique has often been responsible for mistakes and accidents at the hands of the enthusiast.

The introduction of the large auto-con-

trolled transformer, the broad-focus Coolidge tube and the reliable milliamperemeter have made possible the adoption of an absolute standard technique by means of which therapeutic results may be repeated over and over again with almost mathematical accuracy. The important factors that enter into every *x*-ray exposure are (1) the voltage, (2) the milliamperage, (3) the distance from the target of the tube to the surface treated, (4) the length of the exposure in minutes, and (5) the composition and thickness of the filters. The factors likely to produce the greatest degree of variation are voltage and amperage. The auto-controlled transformer and a more reliable milliamperemeter have left little to be desired in the way of apparatus.

More attention in the future must be paid to the standardization of *x*-ray apparatus. The painstaking roentgenologist must have constantly at his command a means of testing his equipment at regular intervals for defects resulting from wear and deterioration. A very slight variation of any one or more of the above five factors will result in a corresponding change in the therapeutic effect obtained. This fact was forcibly brought to our attention several months ago when we were examining several high tension milliamperemeters. After placing these meters in series we were astounded to note that no two indicated the same amount of current passing through them. Which one was correct? We had no means of determining this fact. It was necessary to procure a standard meter before we could determine the error existing in the other meters. We secured a standard milliamperemeter and found that but one out of four of the instruments that we had been using was correct. All were high class meters and were probably correctly adjusted when received from the makers. Two of the milliamperemeters that we had been using extensively, when placed on test with a five-milliampere current, indicated three and seven milliamperes respectively. When the current strength was increased so that the first meter indicated five milliamperes, the actual current in the circuit was about seven milliamperes. When the current was so adjusted that the second meter read five milliamperes, the actual current flowing was about three milliamperes. We believe that every roentgenologist should have a standard milliamperemeter and test all other instruments by it every two weeks, if mistakes and uncertainty are to be avoided when using borderline doses of *x*-rays.

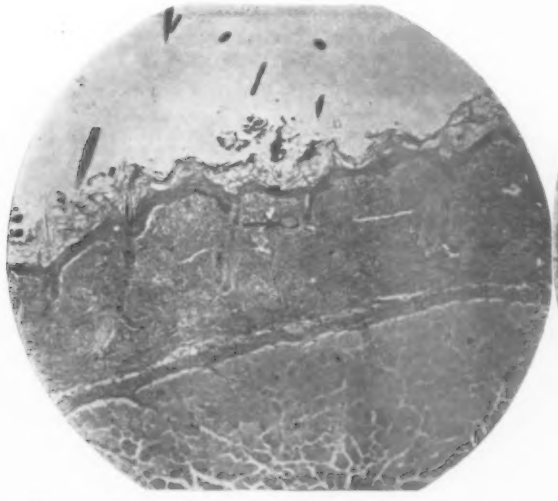

FIG. 5. Skin removed eight days after exposure.

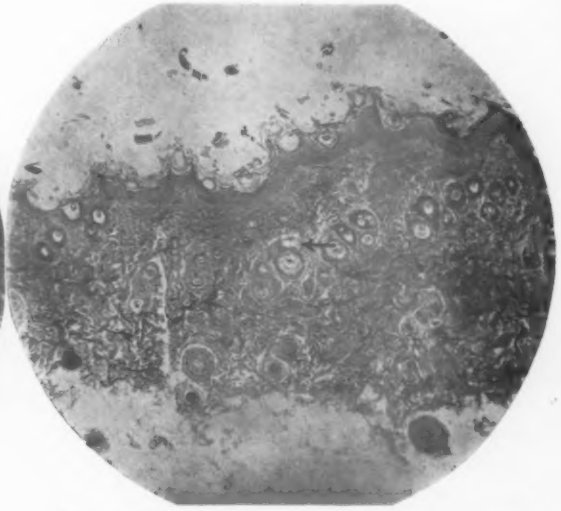

FIG. 6. Skin removed ten days after exposure.

Having overcome the variable milliamperemeter to a practical degree, at least, we began a study of exposures producing a skin

reaction which would be safe in the treatment of superficial skin conditions. After considerable experimental work with an auto-controlled transformer and a broad-focus Coolidge tube the following factors were adopted and have been used regularly and with very gratifying results in the treatment of acne and all superficial skin lesions: (1) A five-inch parallel spark gap; (2) five milliamperes; (3) target skin distance of ten inches; (4) an exposure time of from three to five minutes, and (5) a filter of .5 millimeters of aluminum placed just beneath the tube and a piece of leather placed directly over the area exposed. With these factors a single exposure of twenty-five milliampere minutes will produce a mild degree of reaction in the average skin. This exposure should under no circumstances be repeated in less than a week unless a considerable degree of dermatitis is desired. In the milder types of acne one treatment a week for two or three weeks will usually suffice, but in the deep pustular and indurated types, more active treatment or a much longer period of time and a larger number of treatments will frequently be necessary to accomplish the desired results. In blonds and thin-skinned brunettes, the time of exposure should not be over three minutes. If the first treatment does not produce the desired reaction, as sometimes happens, the period between treatments may be shortened. As a rule, however, one treatment a week under normal conditions will be sufficient to produce good results in all but the most severe types of acne. The Kienboeck quantimeter with its fussy paper strip development, the Holzknecht quantimeter with the barium platino-cyanide pastilles, and the Hampson radiometer which also depends upon a sensitive color reading, have not in our experience been found sufficiently reliable to take the place of the more dependable dosage obtained by factor determination.

FIG. 7. Skin removed twelve days after exposure. Note the thickened collagen bundles, the absence of sebaceous glands and hair follicles. The thickening of the germinal layer and desquamation of the horny layer.

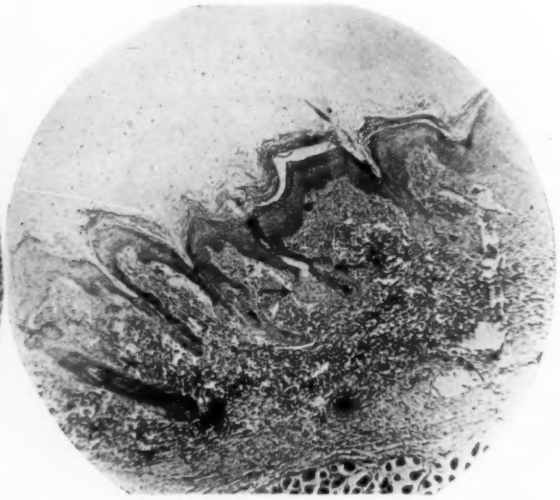

FIG. 8. Large sebaceous glands observed in skin of a guinea pig just outside the borders of a chronic *x*-ray burn.

In discussing any therapeutic measure we feel that it is proper to attempt to demonstrate as nearly as possible the effect produced on the living organism. One may assume that the effects of the roentgen rays applied to the skin in acne are in some way related to the sebaceous glands, but a histological study of such effects has not so far as we know been carried out. It has not been our good fortune for obvious reasons to

obtain sections of skin from patients under treatment; but we have observed certain changes in irradiated skin of animals which may be of interest. In 1919 a series of experiments on animal skin was carried out by one of us under the direction of Dr. S. B. Wolbach at the Harvard Medical School in Boston. A résumé of this work was published in a previous article.[12] However, no special attention was paid to the sebaceous glands at that time and it now seems worth while to point out some of the changes observed. These experiments were undertaken for the purpose of studying the changes that occur in the skin after it has been exposed to an unfiltered dose of soft rays just sufficient to cause tanning and desquamation. Since this is the dose that appears to give good results in acne it seems logical to assume that the changes in the experimental material are probably very similar to those occurring in the subject receiving treatment.

Six white guinea pigs were selected, all of about the same size. The abdomens were shaved and the animals were one after another fastened with their backs down on an animal board and covered with a lead screen in which a square hole measuring 2½ cm. on a side had been cut. This square was so adjusted that it covered a portion of the upper abdomen.

A medium-focus Coolidge tube energized by a Biddle *x*-ray coil was placed directly above the hole in the shield so that the target skin distance was about twelve inches. No filter was used. The skin of guinea pigs is very resistant and it was found necessary to use forty-five minute exposures with a 2½ inch parallel spark gap and ten milliamperes flowing through the tube to produce the desired results. The six guinea pigs were given this exposure on the same day. One animal was killed every two days thereafter, and the skin of the exposed area sectioned. The pig killed on the twelfth day showed a well-marked tan and a definite desquamation. Other animals receiving this dose and observed for a month never developed ulceration and showed no signs of the irradiation except an alopecia.

FIG. 9. Indurated pustular type of acne vulgaris before *x*-ray treatment. July 27, 1920.

FIG. 10. Same case as Figure 9.

Photomicrographs of sections from the exposed areas are shown in the accompanying illustrations. Figure 1 shows a hair follicle and its sebaceous gland in the normal skin of a guinea pig. It is interesting to note how small this gland is as compared with those found in human skin. Figures 2, 3, 4, 5, 6 and 7 represent successive stages in

the development of the roentgen ray dermatitis produced.

The chief changes noted are a thickening and desquamation of the horny layer, a flattening out of the sulci and papilli; a definite thickening of the germinal layer; a gradual shrinking of the hair follicles with loss of the hair shafts; a marked thickening of the collagen bundles of the corium, and a disappearance of the sebaceous glands at about the time that the hair follicles begin to shrink. At the end of eight days there are few such glands in the exposed area, and an occasional one may be observed in the ten-day section, as indicated by the arrows. In the twelve-day section no glands were found. A careful study of the structure of the glands found in the eight and ten-day sections showed no definite evidence of degeneration. This is rather discouraging since these sections seem to indicate that a destruction of the glands must occur at about the time that the hair follicles begin to change. There can be no doubt that the rays have a destructive action on these structures for they are quite plentiful in the sections of normal skin, and their absence in the twelve-day sections can hardly be called a coincidence.

FIG. 11. Illustrating the desquamative stage and the free use of the white wash following the erythema dose of roentgen rays.

It might be assumed that very small doses of rays have a stimulating effect on the glands since they are supposed to stimulate other structures. In support of this assumption, it may be stated that the sebaceous glands shown in Figure 8 are by far the largest observed in any of the material at hand. This photomicrograph shows a section taken just outside of a chronic ulcer in the abdomen of a guinea pig produced by repeatedly exposing the skin with the apparatus already described. Whatever rays reached this region must have been secondary rays coming from the edges of the lead shield. The epithelium is markedly thickened, but none of the other changes observed in tissues receiving direct irradiation are made out.

Since the skin receiving treatment for acne often shows a marked tan and then becomes dry and desquamates, we feel that the sebaceous glands are probably partially destroyed rather than stimulated by the treatment. If this be the case, the other changes described probably occur also. The bearing of such changes on the improvement obtained in acne cases opens up a field for conjecture. If the sebaceous glands are seats of infection in acne, as many investigators believe they are, it seems reasonable to believe that destruction of such glands by means of the roentgen ray should effect a cure just as it apparently does in cases of tonsillitis, where the enlarged tonsil shrinks down under irradiation and becomes a poor place for bacteria to grow.

SUMMARY

1. Acne vulgaris may be confused with acnitis; but since radiation is beneficial in both conditions a differential diagnosis is not essential.

2. All types of acne vulgaris appear to

improve under roentgen ray treatment provided the proper degree of skin reaction is obtained.

3. Good results depend upon a careful application of definite doses of rays accurately measured with meters calibrated at frequent intervals.

4. We find it impossible at the present writing to describe the histological changes resulting from the irradiation of human skin showing acne lesions. It is to be hoped that such studies will be carried out in the near future.

BIBLIOGRAPHY

1. McDonald, R. A. *Yale M. J.*, 1896.
2. Semon. *Brit. M. J.*, 1920.
3. Ketron. *Johns Hopkins. Hosp. Bull.*, 1915.
4. Ullman. System of Instruction. Monell, 1902.
5. Gautier. System of Instruction. Monell, 1902.
6. Schiff and Freund. System of Instruction. Monell, 1902.
7. Campbell. *J. Am. M. Assn.*, Vol. xxxix.
8. Toroeck and Schein. Wien. klin. Rundschau, 1904.
9. Sutton. Editorial *J. Advanc. Therap.*, 1908.
10. Fisher. *N. York M. J.*, 1912.
11. Hazen. *J. Am. M. Assn.*, 1917.
12. Martin. Am. J. Roentgenol., 1919.

Fig. 12. Same case on Jan. 25, 1921. Desquamation is complete and the skin is soft and smooth. The cicatricial scars are less pronounced than before treatment.

Fig. 13. Compare Figs. 9 and 10 with Figs. 12 and 13. The improved facial expression and general appearance of this young man are marked. He has resumed an important position that he held with difficulty before treatment.

THE X-RAY IN DERMATOLOGY*

By C. GUY LANE, M.D.

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BOSTON, MASSACHUSETTS

DURING the past eighteen months the *X*-Ray Department of the Massachusetts General Hospital has been treating skin diseases under a plan slightly different from that formerly employed. One morning a week, and part of the time two mornings a week have been given over to the treatment of these conditions. It is my intention to report briefly:

1. Upon the amount of work which this clinic has done.

2. In a general way, the methods of treatment used in this class of cases.

3. The results which have been obtained during this period.

I. From October, 1919, until April 1, 1921, a year and a half, the total number of treatments for cutaneous conditions has been 656. There have been 989 visits to the clinic for this group of cases. The number of different cases which have been under treatment is 179. Eighty per cent of these cases include the following diseases:

1. Ringworm of the scalp, 45 cases, including both the ordinary form and the cases of favus.

2. Pruritus, 30 cases, including cases of itching, both local and general in character, and of more or less indeterminate origin.

3. Epithelioma, the superficial cutaneous cancers, usually of the basal-cell type, 25 cases.

4. Eczema, 14 cases, mostly chronic infiltrated cases.

5. Acne, 13 cases.

6. Sycosis vulgaris, the pyogenic folliculitis of the bearded area, 12 cases.

The other 20 per cent of the cases include eighteen other diagnoses, only comparatively few of any one diagnosis being treated.

II. In speaking of the methods which have been used in the treatment of these skin conditions, for the sake of convenience I am dividing these cases into four groups.

1. The first group includes those cases in which the treatment has been given by unfiltered rays in small doses; that is, in fractional doses of one fourth to one eighth of the amount necessary to produce erythema on the average skin, the treatments being given every week or every two weeks. This type of treatment has been given to more or less generalized superficial conditions; for example, puritus, eczema, acne and sycosis.

2. The second group includes those cases which have been treated with the unfiltered ray in an amount necessary to produce falling out of the hair, that is, an epilating dose. This amounts to approximately an erythema dose on a sensitive skin. Only one treatment has been given to these cases, which include cases of ringworm and favus.

3. The third group includes those cases to which an unfiltered, rather intensive dose has been given; that is, of one and a half times to twice an erythema dose, repeated after three or four weeks if necessary. This has been given to the epitheliomas and to some of the keratoses occurring on senile skin.

4. The fourth group includes those cases to which a filtered dose has been given, using 1 or 2 mm. of aluminum, and using an amount which is just below an erythema dose. This has been repeated every three or four weeks. This class of cases includes rather sharply localized diseases such as keloid, tuberculosis of the skin, lupus, etc.

As factors in the actual treatment of these skin conditions, the following standards of spark gap, milliamperage, distance and time

*Read before the New England Roentgen Ray Society, May 9, 1921.

have been used. The spark gap has been six inches, measured between points. This same gap has been used even when the filtered treatment has been given. Five milliamperes has practically always been used. A distance of eight or twelve inches from the target of the Coolidge tube has been adopted, varied to a certain extent according to the size of the area to be treated, an eight-inch distance being used on the sharply localized conditions. Occasionally a 16-inch distance has been used on the more generalized conditions and the time increased proportionately. The time has been varied in accordance with the result desired. On the particular apparatus employed in this series a little less than two minutes has been found to produce satisfactory epilation at 8 inch distance, without a filter. For filtration 1 millimeter of aluminum has been used, 2 millimeters occasionally, and 3 millimeters very seldom. In the treatment of ringworm of the scalp the usual Kienboeck-Adamson method of application has been employed, giving one epilating dose to each of five areas.

III. The results which have been obtained may be divided more or less arbitrarily into three groups:

1. Those diseases in which the results have been satisfactory. In this group are certain diseases which respond more satisfactorily to *x*-ray than to any other form of treatment.

2. Those in which the results have been only fair.

3. Those in which the results have been unsatisfactory. This group will show certain diseases in which the results of treatment by *x*-ray in this clinic are not as satisfactory as the results obtained in private practice or reported from other clinics, but this paper has been designed primarily to report upon the results obtained in this clinic by treatment during this particular period of time.

GROUP I

Ringworm.—This is one of the diseases which has responded more satisfactorily to *x*-ray than to any other form of treatment. The superiority of *x*-ray treatment over the older methods is emphasized by two facts; (1) That the duration of the contagious period is shortened; (2) that their absence from school because of the disease is very materially lessened. These cases have been treated, as I have said, by the application of an epilating dose to each one of five areas. A satisfactory epilation has been obtained in the majority of cases, though in the course of standardizing the *x*-ray apparatus a few cases have resulted in insufficient epilation on account of the intention to be on the safe side in instituting a somewhat different method. To date no permanent alopecias have been produced, and only a few cases have shown recurrence, these being among the ones in whom insufficient epilation was produced. It has been particularly interesting to me to observe the good results obtained, with only 70 or 80 per cent epilation, in those cases in which after-treatment has been carried out satisfactorily. At the present time we are in the course of treating an epidemic of nine cases which recently appeared at the Waverly School for Feeble-Minded.

Epithelioma.—It is not my intention to discuss the relative value of surgery, radium, or *x*-ray in such cases, but only to discuss those referred to this department. In only three has there been any difficulty in destroying the lesion. These are probably cases of the squamous cell type. Others, as well as the keratoses, have responded to treatment. I believe that thorough curetting of the lesions before treatment renders fewer treatments necessary, and in many cases one, and occasionally two, treatments have been enough. I believe that the dosage should be nearer twice an erythema dose, unfiltered, in order to obtain the most satisfactory results.

Neurodermite.—This term is the name recently applied to a distinct type of chronic eczema, manifesting itself usually by sharply localized, lichenified, excoriated areas. These areas are usually of long duration, and there

is usually intense itching associated with the condition. These cases, without exception, have become well with fractional, unfiltered doses, administered once a week, or once in two weeks.

Mycosis Fungoides.—This is a serious disease, and tends to progress and end in a fatal outcome. The usual methods of treatment are of no avail. *X*-ray treatment is the only form of treatment which has aided the involution of the lesions and relieved the individual of the intense itching which accompanies the disease. Sooner or later, treatment with *x*-ray fails to produce this effect, but in the three cases which have been treated the itching has disappeared and the lesions have disappeared for the present at least. It is not expected, however, that a cure has resulted. These cases have all been in the earlier stages, without much infiltration or tumor formation, and have been treated by the fractional method.

Chronic Eczema.—These cases have been chronic ones with considerable infiltration, with fissures, and oozing, accompanied by the usual marked pruritus. The majority of these cases have been relieved of the itching, the infiltration has faded away, the fissures have closed, and the skin has assumed a very nearly normal feeling and appearance. They have been treated with the fractional, unfiltered dosage, though a few have been given a little larger dosage, perhaps amounting to one half an erythema dose, and repeated at slightly longer intervals. In those cases which have not responded, I believe that they have not been able to return for consistent treatment, or that it has not been possible for the patient to cooperate with us to a certain degree.

Blastomycosis.—The one case which has been treated was given potassium iodid for a period after he first came to the skin clinic. Very little change in the lesion was noted until *x*-ray treatment was instituted though the dose of potassium iodide was kept at the same amount. This case was found to progress much more satisfactorily still after the use of the more intensive filtered treatments.

Pruritus.—In this condition *x*-ray treatment has been a court of last resort in many cases, and it is more or less surprising to observe the number of cases which have been relieved. There has usually been much previous treatment and there have often been pathological conditions produced in the skin by the scratching. In these latter cases, I feel that the best results have been obtained. In the cases which show very little except a few scratch marks, but complain of a good deal of itching, the relief of symptoms has not been as great. In the long-continued cases of itching often seen on senile skins, the results have not been as good. The vulvar and anal cases have almost without exception been relieved. The time has been too short, of course, to state whether this relief is permanent.

GROUP II

In this class are those diseases in which the results as a whole have not been as good, that is, the results would only be classed as fair.

Acne.—These cases have been treated with the unfiltered, fractional ray, giving one fourth to one eighth of an erythema dose to each side of the face, and one half of this dose to the median line. These treatments have been given once a week, or once in two weeks. A series of eight treatments has been given. In about one half of these cases marked improvement has been noted coincident with the treatment, the first improvement noted being in the lessening of the oily appearance of the skin. I believe that a larger number of these cases will improve under more regular treatment and a longer period of treatment than many of them have received. I further believe that the treatment can be given if care and accuracy are used, without any detrimental after effect on the skin.

Tuberculosis of the Skin.—In tuberculosis of the skin, of the verrucous type, the unfiltered rays were used at first without much benefit. Experience has demonstrated that certain of these will respond to filtered treat-

ment which did not respond to the unfiltered dosage. I believe that it is not wise to prolong the treatment of these cases, or to treat them over a long period of time if there is not a fairly prompt improvement.

Favus.—The favus cases are not as satisfactory cases to treat as the ringworm. They epilate just as readily, but there is more tendency to a recurrence of the condition even with a fairly complete epilation.

Keloid.—The few cases which we have had have not remained under treatment, or they have been treated too recently to form an opinion. The treatment in these cases ought to be satisfactory with fairly intensive filtered treatment.

Acne Keloid.—This condition consists of grouped acneiform areas on the back of the neck, associated with the appearance of small keloidal growths which may coalesce. The keloidal parts of these lesions have responded well, but the follicular infections have tended to continue even under epilating doses. These cases have been treated with a fairly intensive filtered ray, sufficient to produce an epilation. About half of these cases have become well.

Parasitic Skin Disease.—I refer to certain probable ringworm affections of the hands and feet, although it has not been possible to demonstrate any of these organisms in scrapings. Two of these cases, particularly, have made remarkable improvement with the unfiltered, fractional treatment.

GROUP III

This group includes those cases in which the results have been unsatisfactory.

Sycosis.—In sycosis there have been about three of the cases which have cleared up coincidently with treatment by the fractional dose method which I outlined at the beginning of this paper. Certain others have not responded even with epilating doses. Others have not been under treatment long enough to draw conclusions.

Lupus Vulgaris.—In lupus vulgaris the treatment of the older, more chronic type, particularly those which have had a lot of previous treatment of one kind or another, has been most unsatisfactory. In those of more recent development in which a fairly intensive filtered dose has been given the result has been more favorable.

Urticaria.—In the cases of chronic urticaria which have been sent to the clinic for treatment the results have been distinctly unsatisfactory.

Hyperhidrosis.—In hyperhidrosis, prolonged sweating of hands, feet and axillae, the cases under treatment have been somewhat relieved by fractional doses of one fourth to one half an erythema dose, unfiltered; but there has not been as much improvement as would be expected from reports in the literature.

Psoriasis.—Only a few cases have been treated, and these have not been treated consistently or for any length of time. The results have not been satisfactory, but I know that in the chronic, thickened, inveterate patches consistent treatment at proper intervals, over a longer period, in unfiltered fractional doses, will show good results.

SUMMARY

X-ray treatment is invaluable in the treatment of ringworm, epithelioma, certain lichenified eczemas, mycosis fungoides, blastomycosis, many eczemas, and many of the itching dermatoses.

It should give good results in a certain number of the cases of acne, acne keloid, tuberculosis of the skin, favus keloid, certain cases of parasitic skin disease, hyperhidrosis, and psoriasis.

TWO CONTRASTING CASES

(1) ADENOCARCINOMA OF THE STOMACH REVEALED BY ROENTGENOGRAMS, BUT NOT PALPABLE ON EXPLORATION BY THE SURGEON; (2) GASTRIC ULCER NOT SHOWN BY THE ROENTGEN RAY, BUT FOUND AT OPERATION

By RUSSELL D. CARMAN, M.D.

Section on Roentgenology, Mayo Clinic

ROCHESTER, MINNESOTA

THE cases reported here are of interest because one demonstrates the difficulty experienced sometimes by the surgeon in locating a lesion after it has been revealed by the roentgen ray, and one demonstrates that the roentgen ray is not infallible in the diagnosis of gastric ulcer.

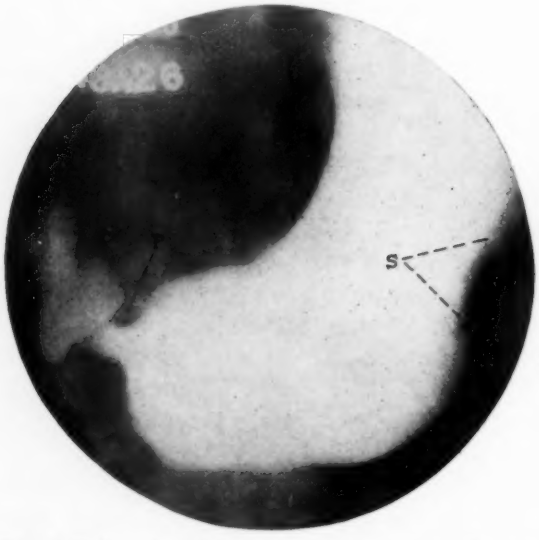

FIG. 1. Deformity of the greater curvature; the posterior wall at S. Note the prepyloric narrowing due to spasm at P.

FIG. 2. Duodenal deformity at D. No niche or deformity suggestive of gastric ulcer.

REPORT OF CASES

CASE 343426. Mr. B. J. H., aged forty-five, examined December 10, 1920, had noticed gradually increasing physical weakness for eight months. During the last two months he had had a fairly constant, dull pain in the epigastrium, without definite relation to the taking of food except that it was not so severe when he did not eat. Recently his appetite had been poor. He had vomited several times but there had been no hematemesis and no melena.

The physical examination, the Wassermann reaction, and examinations of the blood and urine were negative. The contents of the stomach did not show free hydrochloric acid. Roentgenograms revealed a lesion on the posterior wall of the stomach near the greater curvature (Fig. 1).

At operation careful palpation of the entire stomach failed to reveal a lesion. Nevertheless, because of the roentgen ray findings and the absence of lesions in any of the other abdominal organs the stomach was

opened. A superficial ulcerated area 2.5 cm. in its longest diameter was found along the greater curvature. It was shallow and there was no palpable induration on the edges in the surrounding tissue. Microscopic examination revealed adenocarcinoma.

The case is of particular interest, because if the surgeon had found a lesion elsewhere in the abdomen he would have regarded it as a cause of the symptoms and would not have opened the stomach. In this event the roentgen finding would have been considered erroneus. The case also illustrates the value of roentgen findings and the necessity for very careful surgical cooperation.

CASE 354760. Mr. H. L. K., aged forty-nine, had had gastric trouble for thirty-one years before examination at the Clinic, April 7, 1921. The "indigestion" came in periodic attacks, and lasted for from two to three weeks with intervals varying from one to twelve months. The attacks consisted of pyrosis and epigastric pain coming on about two hours after meals, accompanied by "water brash." The patient had a good appetite; food and soda often afforded moderate relief from pain.

The test meals revealed normal free, and combined acid; the roentgenograms showed evidence of an ulcer of the duodenum and a moderate six-hour retention (Fig. 2).

At operation an ulcer of the duodenum was found and excised. The pylorus was hypertrophied and the stomach dilated. The surgeon was at a loss to account for the large stomach and the retention, as there was no obstruction of the duodenum. Since 55 per cent of gastric ulcers produce six-hour retention from the barium meal, the surgeon made a further examination of the stomach and a small ulcer on the lesser curvature, not discoverable in the roentgenologic examination, was found. In a minority of cases of concurrent gastric and duodenal ulcer, it has been my experience that the roentgen examination discloses only one or the other ulcer.

HEMANGIOMA OF THE DUODENUM

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Section on Roentgenology, Mayo Clinic

ROCHESTER, MINNESOTA

THE case of hemangioma of the duodenum reported here is the first that has been encountered in the Mayo Clinic. Its rare and interesting roentgen and pathologic features seem to justify the report.

CASE 356641. Mrs. B. C., aged twenty-two, came to the Clinic April 28, 1921, complaining of having had chronic dyspepsia since childhood. During the last eighteen months she had suffered from two acute attacks of indigestion, lasting about two days, which were considered to be exacerbations of her usual mild attacks with added diffuse epigastric pain and soreness. The milder spells were characterized by nausea and marked frontal headache followed by sour emesis and relief.

The roentgen examination revealed a negative stomach. The duodenum was shadowed as a ring with a translucent center, suggesting the presence of a polypoid growth (Fig. 1). The same appearance was seen at a second examination.

Although the relation between the unusual duodenal deformity and the symptoms was purely speculative, exploration was made. The gall-bladder was negative, the appendix, grade 1, was removed, the stomach was rather thick walled and dilated. The pylorus was wide open; just below the pylorus in the first part of the duodenum was a tumor 7

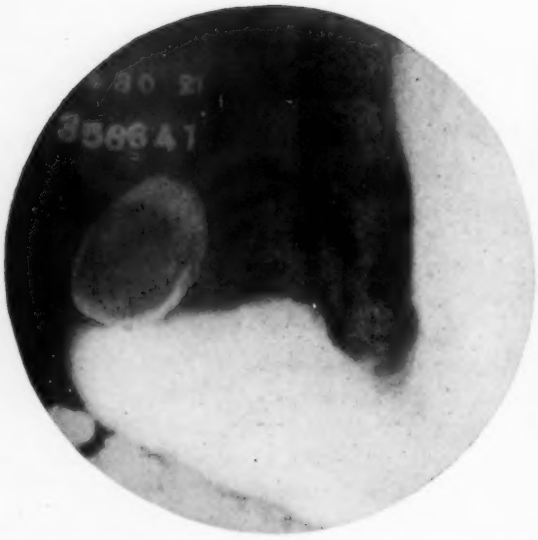

FIG. 1 (356641). Ring or cyst-like detormity of the duodenal bulb, due to polypoid growth.

cm. by 5 cm. completely filling the duodenum and with a sessile attachment to the duodenal side of the pyloric ring. The tumor was easily enucleated through a transverse incision on the anterior surface of the duodenum (Fig. 2).

Pathologic report: Tumor of the duodenum, hemangioma 5 cm. by 4 cm. (Fig.3).

In a casual examination of the literature I have found but one somewhat similar case reported, that of Winternitz and Boggs. This case was that of a male mulatto, aged sixty-five, who also had multiple subcutaneous hemangio-endotheliomas. At necropsy multiple nodules were found throughout the alimentary canal. The entire intestinal wall was beaded with them; they varied from 2 cm. to 6 cm. in diameter and were found in the esophagus, duodenum, throughout the small

FIG. 2 (*above*). Tumor removed from the first portion of the duodenum.

FIG. 3 (*below*). Hemangioma bisected.

and large intestine, and, as subsequently shown on histologic examination, also in the stomach. No roentgen examination of the digestive tract had been made.

BIBLIOGRAPHY

WINTERNITZ, M. C., AND BOGGS, T. R. A. unique coincidence of multiple subcutaneous hemangio-endothelioma, multiple lymphangio-endothelioma of the intestinal tract, and multiple polypi of the stomach undergoing malignant changes, associated with generalized vascular sclerosis and cirrhosis of the liver. *Bull. Johns Hopkins Hosp.*, 1910, xxi, 203-212.

REPORT OF A CASE OF OSTEOMA

By JOHN H. LAMBERT, M.D

LOWELL, MASSACHUSETTS

OSTEOMATA, or osteochondromata are not of rare occurrence, and this case, referred by Dr. A. R. Gardner to me for roentgen diagnosis, is reported not because of the rarity of its type, but on account of its rather unusual size and the interesting features attending its removal.

History.—George G., thirty-six years old, native of Greece, railroad laborer. Father died at seventy-five of pneumonia, mother at seventy of the same disease. Personal history good. Had pneumonia in 1906.

FORMER OPERATIONS.—Scar upper right maxillary region, kicked by a horse, stitches taken.

Chief Complaint.—Growth on right upper humerus. General condition of patient good.

Clinical History.—Patient noticed when in the Greek army, in 1904, a lump on the right shoulder, no pain or discomfort. No interference with the use of the arm in the beginning, but of late a very slight disability, though not marked. General health apparently very good. No loss of strength or weight.

Physical Examination.—Hard, irregular, lobulated mass firmly attached to upper one-third of right humerus, outer aspect. No tenderness. Solid tumor. Physical condition otherwise negative as regards this case.

X-Ray Report.—Attached to the upper third of the right humerus is a large, rounded, dense body 4 inches by 6 inches, showing structure of a bone-like formation, apparently bounded by a definite line and seeming to spring from the shaft about four inches from the head of the humerus on the antero-external surface by an apparent neck about an inch in thickness. The growth extends nearly to the acromion process, partially overcapping the outer portion of the shoulder joint and interfering with its function. The bone structure in the upper part of the humerus is not as well defined as normal, and there appears to be slight rarefaction of the bone in this area. Conclusion: Osteoma arising from a small neck from the upper third of the humerus.

Operation (Performed by Dr. A. R. Gardner at Lowell General Hospital, June 23, 1919).—Incision over right deltoid commencing at about acromion process, extending down arm on inner side of tumor to just a little below middle of arm. Deltoid muscle split, tissue pushed back from tumor on either side. The base of tumor firmly attached into upper third of humerus by a broad base and base extended through the great trochanter into the joint. Larger part of tumor chiseled off rest of tumor, removed by means of chisel and rongeur forceps. Hemostatsis attended to. A few interrupted

FIG. 1. Roentgenogram taken before operation.

sutures inserted in split deltoid. Cigarette drain placed up to capsule; capsule of joint sutured. Interrupted S. W. G. sutures in skin. July 6th; all healed except small area about the size of a dime from which drain was removed, perfectly clean, no evidence of sepsis.

Pathological Report: Gross description. —The specimen consisted of several masses of bone, the largest of which was the size of a grape fruit. The outer surfaces of these bony masses resembled multiple cysts. Histological description: Microscopical examination of specimen shows bone cells. Diagnosis: Osteoblastoma (benign).

Postoperative *x*-ray examination, July 11, 1919, shows that osteoma has been completely removed from shaft of humerus, and there has been thorough eradication of the neck from which it arose, leaving a gouged-out area at the site of the neck. The surface of the bone shows a considerable area on its outer aspect to which the tumor had undoubtedly been attached. There is evidence of a few spicules of bone remaining unattached in the area formerly occupied by the tumor. At this time the function of the shoulder joint seems to be normal.

It is interesting to note that the difficulties of operative removal were considerable, owing to the fact that the tumor had become firmly attached to the shaft of the humerus above its origin, and had involved joint structures, so that a portion of the capsule was necessarily sacrificed in its removal. Many osteomata are slow growing and never attain sufficient size to cause disability, or interfere with function; but it would appear from this case that it would be advisable, on account of the fact that the growth is apt to be toward the joint, to examine them by *x*-rays periodically and determine the point at which they should be removed, in order to avoid encroachment upon other structures that might result in permanent damage and disability.

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Information of interest to all readers and lists of officers of The American Roentgen Ray Society and The American Radium Society will be found on the two pages preceding Table of Contents.

TWENTY-SECOND ANNUAL MEETING THE AMERICAN ROENTGEN RAY SOCIETY

WASHINGTON, D.C., SEPTEMBER 27, 28, 29, 30, 1921

Headquarters, Meetings and Exhibits: Hotel Washington. Hotels: Hotel Washington and The New Ebbitt.

IMPORTANT RAILROAD INFORMATION*

Reduced fares on the basis of the certificate plan have been granted by the following passenger associations to the Twenty-second Annual Meeting of THE AMERICAN ROENTGEN RAY SOCIETY:

Trunk Line Association: N. Y. (east of and including Buffalo, Niagara Falls, Suspension Bridge and Salamanca), New Jersey, Pennsylvania (east of and including Erie, Oil City and Pittsburgh), Delaware, Maryland, District of Columbia, Virginia and West Virginia (east of and including Wheeling, Parkersburg, Kenova, Orange and Norfolk).

Central Passenger Association: Territory west of Buffalo, Niagara Falls, Salamanca, Pittsburgh, Wheeling, Parkersburg, and Kenova to and including Chicago and St. Louis, and north of the Ohio River, including Cincinnati, Louisville and Cairo.

Western Passenger Association: Territory

If the requirements of the Passenger Associations are carried out, there will be *a saving of 25 per cent* on the round trip, which should be worth while for all concerned.

All persons traveling from any point within the territory above named should, when purchasing tickets, ask the agent for a *Certificate* for each ticket purchased (one certificate will *not* do for an entire family or party). This Certificate should be presented at the desk when registering at the meeting.

There will be a railroad man in attendance, and if not fewer than 350 Certificates are turned in, they will be validated and returned to the owners.

The presentation of a validated Certificate will entitle the holder to purchase return ticket at one half of the regular fare. The essential point in this transaction is that no reduced fares will be allowed unless 350

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Since going to press, notice has been received that the *New England Passenger Association*, which includes all railroads in New England, has granted reduced fares on the Certificate plan. Local ticket agents in that territory will give full information.

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Mississippi Rivers. tickets purchased Sept. 25 to 30, inclusive.

*A detailed letter regarding this matter will be sent to all members of THE AMERICAN ROENTGEN RAY SOCIETY prior to the meeting. Others may obtain this letter by addressing the Business Manager, Paul B. Hoeber, 67-69 East 59th Street, New York City.

†At the time of going to press no information has been received as to the action of the Transcontinental Passenger Association covering the Pacific Coast and other far western territory.

TWENTY-SECOND ANNUAL MEETING

The program for the annual meeting of THE AMERICAN ROENTGEN RAY SOCIETY, complete to date, is printed below.

The interest in roentgen therapy, which appears to be quite universal this year, has made it seem necessary to give to therapeutic subjects an even larger proportion of the program than was originally intended.

Those who have not yet sent in abstracts of their papers please do so at an early date.

PROVISIONAL PROGRAM

Cancer of the Uterus. Henry Schmitz, M.D., Chicago.

The Treatment of Brain Tumors by Radiation. Henry K. Pancoast, M.D., Philadelphia.

Progress of Deep Roentgen Therapy. (The Caldwell Lecture.) Dr. Réné Ledoux-Lebard, Paris, France.

Symposium on Therapy of the Thyroid Gland

Some Observations on the Treatment of Hyperthyroidism with X-Rays. George W. Holmes, M.D.

Radiotherapy of the Thyroid. A. F. Tyler, M.D.

The Treatment of Carcinoma of the Thyroid by Radiation. George E. Pfahler, M.D., Philadelphia.

Thyroid Therapy. R. G. Allison, M.D., Minneapolis.

Dr. Holmes will open discussion.

The Roentgen Ray in Dermatology. George W. MacKee, M.D., N. Y., and Henry H. Hazen, M.D.,

The Present Status of Deep Roentgen Therapy in Europe, from a Clinical Standpoint. W. H. Stewart, M.D.

Therapy of Superficial Growths. C. F. Bowen, M.D.

Minimum Erythema Dose with Diagnostic Voltages. Arthur W. Erskine, M.D., Cedar Rapids, Iowa.

The Iontoquantimeter in Measuring Dosage for Deep Therapy. Reginald Morton, M.D., London, Eng.

New Technique for the Vertical Examination of the Sphenoid with Demonstration of the Special Film Holder. George E. Pfahler, M.D., Philadelphia.

The Stereo-Fluoroscope. (Dr. Morgan's stereofluoroscope will be demonstrated under actual working conditions.) J. D. Morgan, M.D., Montreal, Can.

Paget's Disease; Roentgen Studies Relating to its Etiology and Differential Diagnosis. L. T. LeWald, M.D.

Symposium on Education in Roentgenology

Undergraduate Education. F. H. Baetjer, M.D., Baltimore, and H. K. Pancoast, M.D., Philadelphia.

Graduate Education. Geo. W. Holmes, M.D., Boston, L. Jaches, M.D., N. Y., and J. S. Shearer, Ithaca, N. Y.

Gastro-enterostomy Failures Turned into Successes by Appropriate Treatment Indicated from X-Ray Examination. A. H. Pirie, M.D., Montreal, Can.

The Present Status of Pneumoperitoneum as a Diagnostic Aid. James T. Case, M.D., Battle Creek.

Pulmonary Tuberculosis. L. Jaches, M.D., and H. Wessler, M.D., New York City.

Benign and Malignant Gastric Ulcers from the Roentgenologic Viewpoint. Russell D. Carman, M.D.

Ossification of the Meninges. H. M. Imboden, M.D., and C. A. McKendree, M.D., New York City.

Dental Roentgenography in the Light of Clinical and Pathological Findings. Allan Scott Wolfe, D.D.S.

(Subject not received.) Willis F. Manges, M.D.

X-Ray Treatment of Diphtheria Carriers. P. M. Hickey, M.D., Detroit.

Dr. Witherbee will open discussion.

Demonstration of Simplified X-Ray Unit for Treatment of Tonsils and Adenoids; Exophthalmic Goiter, Tubercular Glands of the Neck and Enlarged Prostate. W. D. Witherbee, M.D., New York City.

(Subject not received.) John W. Pierson, M.D.

Value of Interstitial Radiation. Douglas Quick, M.D.

X-Ray Evidence of Abnormal Small Intestinal States Embodying an Hypothesis of the Transmission of Gastro-intestinal Tension. (Illustrated by Lantern Slides.) R. Walter Mills, M.D., St. Louis.

The Relation of Temperature Changes to Roentgen Ray Skin Reaction. Charles L. Martin, M.D., and George T. Caldwell, M.D., Dallas, Tex.

The Efficiency of the Bucky Diaphragm Principle. R. B. Wilsey, Rochester, N. Y.

The Roentgenological Aspect of Sprengel's Deformity (with lantern slides). Edward S. Blaine, M.D.

Epithelioma of the Cornea. D. Y. Keith, M.D.

Filtration and Scattering. J. S. Shearer, Ithaca, N. Y.

Pyelitis of Pregnancy. F. M. Hodges, M.D., Richmond.

Studies on Injected Kidneys, W. K. Lim, M.D.

Studies in Roentgen Ray Deep Therapy: 1. Studies on the Penetration of Rays in Tissue; 2. Electrical Studies. Prof. F. Dessauer, Frankfurt am Main.

The Operation of X-Ray Tubes at 200,000 to 300,000 Volts (Maximum). W. D. Coolidge.

Limitation of X-Ray in Fracture Work. Roland Hammond, M.D., Providence, R. I.

Use and Abuse of Radium and the Roentgen Ray in Treatment of Epithelioma. Russell H. Boggs, M.D.

The Lumbar Spine and Sacro-Iliac Joints. M. B. Palmer, M.D., Rochester, N. Y.

The Diagnosis and Removal of Foreign Bodies from Bronchus and Esophagus. C. F. Bowen, M.D.

The Differential Diagnosis of Ulcer, Adhesions, and Congenital Membranes Involving the Extreme Pyloric End of the Stomach and Cap and their Surgical Significance. Louis Gregory Cole, M.D.

Possibilities of Treatment in Pancreatic Carcinoma. G. E. Richards, M.D., Toronto, Can.

Intensive Therapy in Germany. Samuel Stern, M.D.

The lantern slide exhibits at meetings of THE AMERICAN ROENTGEN RAY SOCIETY have always been a very interesting and instructive feature. According to custom, one evening has been reserved for this purpose, but up to the present time only a few members have indicated their desire to show slides. Presentation of slides is not confined to members of the Society. Any guest of the Society may reserve a place on this program, but names will be listed in the order received.

Please send in your name as soon as possible and indicate the number and nature of the slides you will show.

Following precedent, we are publishing in this issue the portrait of the President of THE AMERICAN ROENTGEN RAY SOCIETY, Arthur C. Christie, M.D.

CORRESPONDENCE

FROM COMMITTEE ON SAFETY

At the last annual meeting of the AMERICAN ROENTGEN RAY SOCIETY it was voted to appoint a committee on safety.

In order that this committee may give proper consideration to the various matters involved, they request the cooperation of the medical profession in the collection of data in regard to injuries due to the operation of *x*-ray apparatus.

Readers of this JOURNAL are requested to give the committee any information they may have. No names of institutions, physicians or patients need be given, and information will be regarded as confidential in any case. The following list suggests some of the information that would be of service. As far as possible the exact conditions under which the injury occurred should be given.

ELECTRIC SHOCK

1. Number of injuries observed or reported.
2. The extent and nature of each.
3. Incurred during (*a*) Treatment,
   (*b*) Fluoroscopy,
   (*c*) Radiography.
4. Type of apparatus in use:
   (*a*) Large transformer,
   (*b*) Small type transformer,
   (*c*) Induction coil.
5. Control resistance: Auto transformer.
6. Type of support on which the person injured was placed:
   (*a*) Standing on floor of { tile / concrete
   (*b*) On wooden table, { wood
   (*c*) On a metal table.
7. If the latter, was it grounded?
8. Any information as to actual or supposed special conditions at the time of injury.
9. Was the tube or apparatus damaged?
10. Was the accident due to any failure of apparatus?
11. Was the room damp or wet?

INJURY DUE TO *x*-RAYS

1. Extent and seriousness, i.e.,
   (*a*) Simple dermatitis,
   (*b*) Second or third degree dermatitis,
   (*c*) Telangiectasis,
   (*d*) Temporary loss of hair,
   (*e*) Permanent loss of hair.
2. Was the patient being (*a*) fluoroscoped, (*b*) radiographed, (*c*) treated?
3. What type of apparatus was used?
4. What current—spark-gap—distance—filter—time, was used?
5. Was any method of measuring skin dose employed?

It is the aim of this Committee to determine the prime causes of accidents and the best means of preventing them, without interfering with the utilization of the rays or causing needless expense. Also a few simple rules for the guidance of manufacturers and roentgenologists may be worked out.

Communications may be addressed to any member of the Committee, or to Miss Doris Keeler, Sec., Rockefeller Hall, Ithaca, N. Y.

W. D. COOLIDGE, Schenectady, N. Y.
P. M. HICKEY, M.D., Detroit, Mich.
H. K. PANCOAST, M.D., Philadelphia.
G. W. HOLMES, M.D., Boston.
J. S. SHEARER, Ithaca, N. Y.

To the Editor:

Dear Sir: There seems to be a considerable difference in opinion with reference to the positioning of an *x*-ray tube when producing stereoscopic pictures. There follow a number of varied opinions from different sources, including one of the largest manufacturers of *x*-ray equipment, one of the largest manufacturers of photographic supplies, a doctor in the United States Public Health Service, and one of the leading optical manufacturers.

The writers of these opinions do not wish to have them published over their names, but they serve to illustrate the point in question.

I also have the following comments of one of the above authorities with reference to the article which appeared in THE AMERICAN JOURNAL OF ROENTGENOLOGY for November, 1920, (page 564), showing the application of the stereoscopic tube-stand adopted for the examination of the skull, as used in the Department of Roentgenology at the Union Medical College at Pekin, China.

"I believe that in China the method of stereoscopy as outlined in the article to which you referred me might be very adequate. I am not convinced that in America the method outlined is at all standard. I am unswerving in the belief and scientific conviction that stereoscopy consists in shifting the central ray the distance that the eyes are apart; *and that this shifting must be equal for all parts stereoscoped.* In China the method by you described does not even show how much shifting is done, and if it did show it would

still be more for that part of the body nearest the tube than for the part of the body nearest the plate."

Other opinions follow:

"Our opinion is that if we assume a line exactly at right angles to the plane to be photographed, that is a perpendicular line to the plane, then one picture should be made with the target of the tube set at a distance from this line equal to one half the normal eye separation or approximately 1¼ inches, and then it can be rotated about its horizontal axis so that the target is pointed at the point on the object intercepted by the perpendicular line referred to. The second position of the tube would be the same distance the other side of the line with the target again rotating until its rays intercept the object at the point of the normal. In other words, the two pictures, in our estimation, should be made with a separation along a horizontal line of approximately 2½ inches between the two locations of the target and with the tube rotating *so that in each case the target would be pointed to the same spot on the object.* This is a procedure necessary in ordinary photography in order to secure stereoscopic pictures.

"The theory of stereoscopy is based on binocular vision in which two images must be presented, each image differing from the other in its focal angle to an amount equivalent to the difference between the visual axis of the observer's eyes (60 millimeters, normal). In making the tube shift Kennon Dunham very tersely explains on page 6 of his reprint entitled *X-Ray Chest Manual,* reprinted from the transactions of the 14th Annual Meeting of the National Tuberculosis Association: *'The tube must move through a plane parallel to the plate.'* The essential pith of my argument is that the tube should not be tilted but should be moved in its entirety in a plane parallel to the plate.

"Taking into consideration the physics and practical construction of modern *x*-ray tubes, there would be *no fundamental difference in making stereoscopic negatives whether the tube was shifted in a plane or rotated in the arc of a circle;* the only condition which it would be necessary to fulfil being that the circle of rays covered on the plate satisfactorily covered the subject.

"There, of course, might be a theoretical case where a long narrow cylinder was used where this would necessarily have to be tilted in order to cover the object, but in the average practice it would certainly not be the case. Even in the case of the use of the Bucky-Potter diaphragm the writer doubts

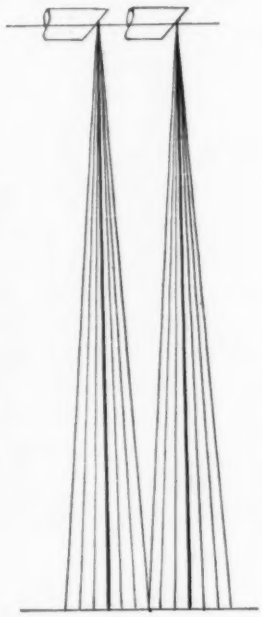

FIGURE 1

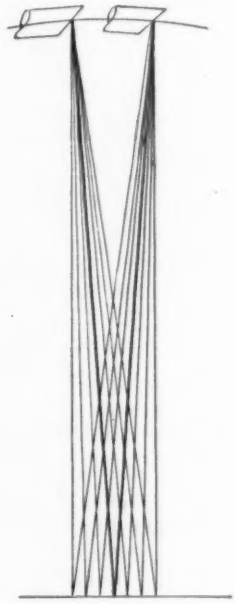

FIGURE 2

if there would be any necessity of shifting the tube in the arc of a circle.

"I do not see that it makes any difference *whether the tube is rotated or not* so long as the required lateral movement of the focal spot is obtained and the opening in the shield or side of the cone (if they used one) does not cut off any of the required beam of rays."

Figures 1 and 2 illustrate the two types of position for stereoscopic radiography. Figure 1 shows the target of the tube moved through the proper distance, but in a plane horizontal with the plate. Figure 2 shows the target of the tube moved through the proper distance but through an arc, so that the central ray is at all times focused at the same spot on the plate.

At first glance, it would appear that we have two entirely different conditions. Con-

sidering, however, the characteristics of the field of examination of *x*-rays from the target of the tube, there is practically no difference between the effect produced on the plate in either Figure 1 or Figure 2.

In order to make this point clear, we must get the idea in mind that the *x*-ray emanates from a point source, and that it is emanating from this source in all directions in front of the plane on which this point is located, the strongest rays of course at the very center, and gradually diminishing to nothing on a line parallel to this plane.

After we have this clearly in mind, and looking at Figure 1, we find that there are in effect only two points at which the rays strike the plate at a true perpendicular, and that is at a point directly below the target in each position. At any other point on the plate the rays must necessarily strike at a varying angle.

Now considering Figure 2, where we have rotated the targets in such a manner that they focus in either position on the same point on the plate, we have the two central rays both hitting the same spot, while the weaker rays go correspondingly around this spot.

It will be seen that if we take the rays from the target in Figure 1 that come together in the central part of the plate, or in other words, the center distance between the two spots directly below the target, they strike the plate at the same angle as the two central rays in Figure 2, which emanate from the targets rotated through their distance rather than move through the parallel plane.

It is obvious in the same connection, that if we were attempting to take a stereoscopic radiograph of a grain of corn, or other small article, less than the distance through which we move the center point of the target, and if the only *x*-ray that was given off was the one central ray, we would not get any radiograph of this small object if placed at the central point between the two points directly in front of the focal spot on the target.

It is equally obvious that with a body of any size in position to be radiographed, a line drawn from the focal spot from the target to any spot on this body and continued through that spot to the plate, will strike the plate at the same angle, irrespective of whether the target is slightly tilted or in such position as to direct the central ray perpendicularly towards the plate.

Thus it appears that as long as the target is moved the required distance each side of the center, it makes no difference whether the target was moved on a straight line keeping the central ray directed perpendicularly towards the plate, or whether the target was moved through an arc and tilted, so that the central ray is directed towards the plate at an angle.

G. Leslie Griffith
International Devices Company
326 Broadway, New York.

OBITUARY

William Ironside Bruce, M.D. (Aberdeen)

"Do you happen to know anyone who wants to take up an *x*-ray practice in the west end of London? I have been told to give up *x*-ray work and get out into the country." This was the substance of the last letter I had from my friend Bruce just a week before the news of his death. He knew that the *x*-rays had marked him down and that there was one, and only one, course open to him, namely, to haul down his colors and to go right away from the work he loved and the position he had built up with much labor. There was no whimpering, no self-pity! He took his sentence like a soldier and hoped that he would regain health and strength when the effect of the radiations to which he had been unduly exposed, had worn off. This, however, was not to be. The aplastic anemia from which he suffered, and which he and the medical officers in attendance attributed to *x*-rays, caused his death on March 21, 1921.

Ironside Bruce, born in 1876, was the son of a medical man practicing at Dingwall in Aberdeenshire. He went to the University of Aberdeen, taking his degree there in 1900. The call of war took him to South Africa as a surgeon, and during this service he came in

contact with those who were doing *x*-ray work in the field. His keen interest in the subject was aroused, and when he returned he took up a post as assistant to the late Sir James Mackenzie Davidson at Charing Cross Hospital. When his chief retired, Bruce was appointed to fill the post, and as chief of this department he worked until his death. In addition he undertook the charge of the *x*-ray department of the Great Ormond Street Hospital for Children.

Of a mechanical turn of mind, Bruce did a great deal in the early days in designing apparatus, and there are several simple and effective contrivances that bear his name and are still in constant demand, especially his couch with its "plumb-bob." During the war, he worked in the *x*-ray department of the military hospital to which he was attached, on the subject of the extraction of foreign bodies. His *x*-ray room was made into an operating theater, and his director operating couch was so contrived that, having located the foreign body, a director needle could be swung into position, into the wound, and would direct the surgeon straight to the foreign body.

When the idea of a diploma in radiology was mooted, Bruce was a very active supporter and took a keen interest in the project. Later on, when the scheme was put into effect, he took a share in the lecturing and was one of the most successful of teachers.

But first and foremost, Bruce was a man —a most lovable man, with a boyish exuberance of vitality and a charm that won affection wherever he went. Nobody could be with him without feeling the force of his personality and the good-humored joyous life of the man who was still a boy at heart. He was particularly fond of children, and nearly always succeeded in quieting their fears when they came as patients. His knowledge of human nature was profound, and in addition he had that intuitive perception and unconscious power of deduction that made his opinions of very great value. In the interpretation of radiograms his apparently lightning diagnoses were extraordinarily accurate, for he had a long experience, a good memory, and back of it all this unconscious reasoning and sound common sense that made his opinions of inestimable value.

In Bruce's death we have sustained a very great loss, the loss of a leader who had made his mark, and whose fearless and outspoken opinion was often the deciding factor in difficult situations.

A. E. Barclay.

AMERICAN RADIUM SOCIETY*

WHEREAS, During the past year there have been removed from our midst and from our membership by death three physicians prominent in the inception of this Society and in the development of the science of the therapeutic employment of radium, viz.:

Dr. Walter B. Chase, of Brooklyn, a charter member and one of the first Americans to employ radium for therapeutic purposes;

Dr. Howard W. Longyear, of Detroit, the well-known gynecologist, whose interest was helpful in the very beginnings of this organization, and whose efforts we shall long remember as contributing to the establishment of radium as a recognized adjunct in gynecology;

And Dr. Henry Harrington Janeway, head of the Radium Department of the Memorial Hospital, New York, especially notable for his efforts to standardize dosage and render the application of radium more accurate, for his early work in the treatment of uterine carcinoma particularly, and as being first in America to use radium emanation buried in tumor growths;

Therefore be it

RESOLVED that this Society express to the bereaved families of these deceased members our sincere sympathy in their loss; and further be it

RESOLVED that a copy of these resolutions be spread upon the minutes as a token of our gratitude and pride in the accomplishments of these departed members.

*Resolutions adopted by American Radium Society at its Sixth Annual Meeting, June 6, 1921.